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Coping with Human-Elephant Conflict in Laikipia District, Kenya



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In many parts of Africa, large herbivores find their way into private lands, competing for forage with livestock and destroying crops. In Kenya, elephants (*Loxodonta africana*) pose a real threat to subsistence farmers at the interface between the elephants' range and agricultural land. Conservation and land use strategies and policies in Kenya do not take into account the needs of the rural poor and tend to prioritize wildlife protection at the expense of the people. At the same time, rapid population growth has put protected areas under intense pressure through encroachment. Human-elephant conflict is only a microcosm of the wider ecological struggle for survival between humans and wildlife.

In this study, data is analysed on human-elephant conflict in the subsistence smallholder farming areas in south-western Laikipia. The study investigated the human-elephant conflict patterns and the various measures deployed by smallholder farmers to protect their crops from elephant incursions. The results show that: 1) Crop raiding is the most common form of HEC in Laikipia, 2) Farmers in Laikipia extensively deployed traditional techniques, 3) Contrary to the widely held inefficacy of these techniques, they were effective in the short term, 4) Most HEC incidents were not detected while in progress and 5) The Kenya Wildlife Service was unable to attend to many complaints despite nearly all the incidents being reported.

Based on the interpretation of the results, two models for coping with human-elephant conflict are identified: 1) To strengthen the capacities (traditional conflict mitigation techniques) and the knowledge of the local people sharing their landscape with elephants to cope with human-elephant conflict and 2) The promotion of alternative livelihoods that consider wildlife compatible practices through a comprehensive land use and conservation policy review to integrate both human and wildlife needs.

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List of acronyms

ADC	Agricultural Development Corporation
AefSG	African Elephant Specialist Group
ASALs	Arid and Semi-Arid Lands
CETRAD	Centre for Training and Integrated Research in ASAL development
CLOs	Community Liaison Officers
CITES	Convention on International Trade in Endangered Species
GIS	Geographic Information System
GPS	Global Positioning System
GSM	Global System for Mobile communications (<i>Groupe Spécial Mobile</i>)
HEC	Human-Elephant Conflict
HECTF	Human-Elephant Conflict Task Force
HECWG	Human-Elephant Conflict Working Group
HWC	Human-Wildlife Conflict
ILRI	International Livestock Research Institute
IUCN	International Union for Conservation of Nature
KWS	Kenya Wildlife Service
LWF	Laikipia Wildlife Forum
LEP	Laikipia Elephant Project
NGOs	Non-Governmental Organizations
NPs	National Parks
NRs	National Reserves
PA	Protected Area
PAC	Problem Animal Control
SPSS	Statistical Package for Social Sciences
USAID	United States Agency for International Development
UTM	Universal Transverse Mercator
WCMD	Wildlife Conservation and Management Department

Chapter One

Introduction

The poverty and conservation debate is increasingly becoming sophisticated (Adams *et al.*, 2004) with many actors calling on conservation and conservation organizations to address the ‘vacuum’ created by the development in poverty alleviation (Redford *et al.*, 2003; Koziell and Saunders, 2001; Roe *et al.*, 2003; Brockington and Schmidt-Soltau, 2004). As Roe and Elliott (2004) argue, there is need for a paradigm shift in conservation approaches. There is widespread recognition and documentation of the social impacts of PAs (McNeely and Miller, 1984; McNeeley, 1999; Adams and Hulme, 2001; Emerton, 2001; O’Riordan and Stoll-Kleeman, 2002; Igoe, 2006). However, the opponents such as Brandon (1998) argue that conservation and poverty are different problems and that parks are unfairly being made responsible for curing structural problems such as poverty, unequal land and resource allocation, corruption, injustice and market failure.

People living in and around PAs have exploited wildlife species for food and furs from time immemorial with sporting and cultural exploits being reported in recent times (Woodroffe *et al.*, 2005). They have also suffered direct costs such as crop depredation (Naughton-Treves, 1997; Sekhar, 1998; Woodroffe *et al.*, 2005) and labour and opportunity costs of crop defence. Humans have killed wildlife species in response to damage and losses (Woodroffe *et al.*, 2005). Furthermore, park neighbours resent ‘injustices’, by PA staff, particularly linked to minor infringements of park boundaries such as illegal grazing, or regulations by demanding bribes to avoid arrests for cutting fuelwood, or collecting medicinal plants (Adams and Hutton, 2007).

The overlap in wildlife requirements with those of human populations creates costs to both residents and wild animals (World Parks Congress, 2003) and hence human-wildlife conflict (HWC). The escalation of the severity of HWC threatens the survival of the species involved, particularly the threatened and endangered species such as the Sumatran tiger (*Panthera tigris sumatrae*), the Asian lion (*Panthera leo persica*), the African elephant (*Loxodonta africana*) and the Asian elephant (*Elephas maximus*) as well as the less endangered species such as the snow leopard (*Uncia uncia*) and the Red colobus monkey (*Procolopus kirkii*) (Woodroffe *et al.*, 2005).

The fear of being killed by large carnivores or trampled upon by mega herbivores has intensified HWC in shared landscapes (Kruuk, 2002; Quammen, 2003). Specifically, the severity in the

tropics and developing countries, where livestock holdings and smallholder agriculture is the mainstay of rural people's livelihoods and incomes hence higher vulnerability, has reduced human appreciation for wildlife (De Boer and Baquete, 1998; Nyhus *et al.*, 2000). Consequently, many residents consider wildlife a liability that should not continue occupying space that could otherwise be used for more beneficial activities. The question is; to what extent are these impacts felt at local levels sufficiently to alter the course of wildlife conservation?

1.1 Human-wildlife conflict mitigation

Human wildlife conflict mitigation and management is as old as agriculture. In AD 800, Emperor Charlemagne engaged professional wolf-hunters to kill wolves from the Holy Roman Empire (Boitani, 1992). Individuals, informally organised communities, bounty hunters, and local and national governments have killed problem animals both legally and illegally in conflict mitigation by shooting, poisoning and trapping where resources are available, and using crude traditional techniques such as arrows and spears to more cruel methods like stoning to death where resources are a barrier.

Livestock herders in North America deploy innovative but highly selective methods to secure their livestock from coyotes. Protective collars are fitted to livestock (sheep) strategically to ensure that only those coyotes that bite the throat of the sheep, piercing the collar, come into contact with the collar's reservoir of the 1080¹ poison and ultimate death (Burns *et al.*, 1996). In East Africa, large carnivores like lions and leopards (Frank *et al.*, 2003) as well as African elephant and chimpanzees (Ghilglieri, 1984; Moss, 2001) were speared to death. In Asia, aggrieved farmers deliberately packed explosives into jackfruit baits or modified power lines to electrocute crop raiding elephants (Menon *et al.*, 1998). Consequently, a 17% and 57% increase in female and male Asian elephant mortalities respectively were reported with a marked decline in the overall Asian elephant populations in the southern India (Sukumar, 1989).

¹ According to the World League for Protection of Animals, 1080 poison is a slow killer. When ingested (usually through baited food) the animal suffers a prolonged and horrific death. Herbivores take the longest to die – up to 44hrs, while carnivores can take up to 21hrs before finally succumbing to final effects of the poison. The speed of death is dependent on the rate of the animal's metabolism. (http://www.wlpa.org/1080_poison.htm)

The ultimate aim of conflict mitigation is to secure livelihoods and to reduce losses attributed to wildlife. Even though some deaths of wildlife species such as elephants are as a result of poaching destined for the market, the worst cases are those linked to the HWC.

1.2 Implications of human-wildlife conflict

Human-wildlife conflict has a two pronged effect: To conservation especially of the threatened and endangered wildlife species and to humans as a threat to livelihoods. Evidence shows that species most exposed to conflict are also more prone to extinction (Ogada *et al.*, 2003). The Norwegian government approved the killing of 25% of the country's remaining wolves in 2005 to appease sheep owners (Kirby, 2005) leading to an extirpation (See also Greenaway, 1967; Fuller, 2000; IUCN, 2002). Similarly, overstocking and grazing into designated wildlife zones, especially in the ASALs, 'competitively exclude' some wildlife species. These human-induced extirpations affect the population viability of the most endangered species with broader environmental impacts on ecosystem equilibrium and biodiversity preservation (e.g. Ray *et al.*, in press).

The growth in human population has increased demand for resources and access to land for agricultural expansion and grazing space. Consequently, sedentary agriculture has spread to more marginal rangelands. With more than 80% of African rangelands teeming with wildlife, much of which live outside protected areas (Muruthi, (2005), HWC, considered inhibitive to human welfare, health and safety, with economic and social costs is inevitable. According to Muruthi, (2005), such impacts, are an indication that governments, wildlife managers, scientists and local communities need to recognize the problem and adopt measures to resolve it in the interest of human, wildlife and environmental well being. In the event of failure, further extinctions with associated consequences for regional biodiversity are inevitable (Woodroffe *et al.*, 2005).

Contrary to the developed continents such as Europe, African residents contend with HWC albeit with minimal comfort. There is need to ensure some form of peaceful coexistence especially where and when people and wildlife share landscape. However, overwhelming evidence shows that at least with the increasing human population, human wildlife conflicts will not be eradicated in the near future.

1.3 Human-wildlife conflict species: Are elephants the worst?

Studies have shown that a wide range of wildlife species are involved in HWC. Primates, rodents and ungulates are considered the worst, but also implicated are the lions, leopards and hyenas (Hill, 2000; Naughton-Treves, 1998; Naughton-Treves, *et al.*, 1998; O'Connell-Rodwell *et al.*, 2000; Saj *et al.*, 2001). However, livestock is overlooked in the HWC practice since local measures are in place to mitigate their limited impacts (Naughton-Treves, 1998)

Elephants, buffalos, monkeys and baboons are serious crop pests in many parts of Africa and Asia. What is not clear is whether elephants are the 'worst pest' as is often implied by the rural farmers. Indeed, on very few occasions are large vertebrates ($\geq 2\text{kg}$), including elephants, mentioned as pests in tropical agriculture alongside insects, nematodes and other taxa. However, they feature prominently as localised problems associated with protected areas (Golman, 1996; Southwood, 1977). Specifically, the exclusion of elephants has obscured their implication in conflicts at regional and national scales (Naughton-Treves *et al.*, 1999).

Naughton-Treves *et al.* (1999) in their report to the IUCN explained that elephants were responsible for crop losses in many African countries ranging from 0.2% in Niger to 61% in Gabon, with over 20 different crops attacked. Elephants ranked among the top five most dreaded pests alongside primates, rodents, bush pigs and antelopes out of the 38 species that were investigated (Naughton-Treves *et al.*, 1999). In the East Caprivi, Namibia, despite lions constituting a larger economic loss of N\$189 760 compared to elephants' N\$85 156 between 1991 and 1994, elephants were responsible for 47% of total recorded conflict incidents (O'Connell-Rodwell *et al.*, 2000) constituting a higher claim by local farmers.

The elephants' ability to cause severe damage in a single incursion (Barnes *et al.*, 1995; Hillman-Smith *et al.*, 1995; Lahm, 1996; Naughton-Treves, 1998) is felt more than frequent raids, even if these cumulatively cause more damage (De Boer and Baquete, 1998; Hoare, 1999a; Naughton-Treves, 1997; Naughton-Treves, 1998). In addition, elephant raiding patterns at local levels are spatially and temporally unpredictable but highly linked to forest and protected area boundaries, water sources and corridors (Dudley *et al.*, 1992; Naughton-Treves *et al.*, 1999). These resources and locations attract human activities hence conflict with elephants. As a result, elephants have a

higher profile than other wildlife species and are generally less easily tolerated (Naughton-Treves *et al.*, 2000; Hoare, 2001).

1.4 Problem statement

Elephant conservation issues in Africa have evolved in response to research and policy in dense populations in protected areas in the 1960s (Buechner and Dawkins, 1961; Laws, 1970; Laws *et al.*, 1975) and the impacts of illegal hunting for ivory on elephant populations in the 1970s and 1980s (Douglas-Hamilton, 1987; Parker and Graham, 1989). Today, the growing human population coupled with agricultural expansion constitute major threats. Consequently, human elephant conflict (HEC) has become a major conservation issue in Africa and Asia (Bell, 1984; Sukumar, 1989)

Despite this growing attention to HEC at the human-elephant interface, particularly crop raiding (Hoare and Du Toit, 1999; Hoare, 2000), uncertainty persists as to how best HEC can be minimized. High-tech interventions favoured by donors and wildlife authorities, such as electrified fences, translocation and shooting are expensive and selective in impact (Thouless and Sakwa, 1995). Consequently, HEC is increasing at local levels causing a major threat to rural livelihoods.

Due to poverty, most rural communities across Africa and Asia employ inexpensive, low-tech, non-fatal HEC mitigation methods (Bell, 1984; Hoare, 2001; Sukumar, 1989; Nyhus *et al.*, 2000). Extensive use of passive and active methods in crop protection has been documented with mixed results but many HEC practitioners concur on the ineffectiveness of these methods. Their increasing use and favour among rural farmers, begs the question as to why the poor and vulnerable farmers would persistently use them to defend crops knowing they will not be able to defend them effectively? It is vital, therefore, to gain a thorough understanding of the problem in order to develop and direct mitigation strategies. However, the exploration of the efficacy of HEC mitigation techniques is hampered by the limited data and documentation of the objective tests.

1.5 Research objective and questions

The objective of this research therefore is to contribute to the HEC documentation and practice through a critical examination of the HEC mitigation techniques currently in use in three study

sites² in Laikipia District, Kenya. The study aims to explore the various techniques employed by smallholder farmers and the institutional³ involvement in conflict mitigation. An examination of the efficacy⁴ of the conflict mitigation techniques is provided to establish how they enhance capacity to cope with HEC in Laikipia. The study further examines the elephant crop raiding patterns and characteristics⁵. To achieve these, the following research questions have been developed.

1. What techniques are used to mitigate HEC in Laikipia and who is responsible for their use in the district?
2. Which of the techniques is widely used, and how have they enhanced the capacity of smallholder farmers to cope with HEC in Laikipia?
3. How do elephants respond to the deterrent techniques? And what assumptions can be drawn from this to verify the efficacy of the mitigation techniques?

² The study sites are selected among eight study sites that have been investigated by the Laikipia Elephant Project for over five years. The focus on the three; Rumuruti, Mutara and Olmoran, is motivated by logistical and time constraints.

³ In this context, Institutions are mainly the Kenya Wildlife Service and the private and government ranches within the three study sites.

⁴ Efficacy in this context refers to the elephant reaction whenever a deterrent is used.

⁵ In this context, this refers to the elephant group types including sex, group numbers, timing of raids and crop types.

Chapter Two

Context

2.1 Land use, livelihoods and conservation

The complexity and diversity of political ecology of conservation can best be explored in both the modern conservation approaches and the colonial centralised approaches. At independence, African governments inherited the colonial conservation policies and approaches considered draconian, unpopular and exclusionary, that favoured the west (Gibson, 1999) and effectively considered many land use practices as detrimental to biodiversity conservation. This ‘Fortress conservation’ imposes heavy costs on local people without bringing commensurate benefits. However, the economic outcomes only represent one dimension that needs to be arched by the social institutions associated with conservation management to enhance representation and participation. Community-based conservation is new paradigm in the conservation sphere (Hulme and Murphree, 1999.) that might be exploited to achieve inclusive conservation goals.

PAs, defined as a ‘geographically defined area designated or regulated and managed to achieve specific conservation objectives’ (Pienkowski *et al.*, 1996) form the foundation of the ideas of nature upon which the needs, rights and interests of people are gauged to achieve the conservation results (Adams and Hutton, 2007). Consequently, in many developing countries, PAs have contributed immensely to the protection of biodiversity from development and land conversion, but on the same footing, they have impoverished the majority of park neighbours through the over protectionist tendencies (Inamdar *et al.*, 1999).

Habitat conversion, particularly, to agriculture, urban development and human overexploitation (Bultea and Horanb, 2003) and the resultant changes in land-use/land cover (Reid *et al.*, 2000) are strongly linked to the human population growth. The intricate relationship between ecosystem functions and biodiversity conservation is further complicated by the occurrence of major biodiversity rich areas in agriculturally suitable lands hence conversion for agriculture is undoubtedly the single most important threat to conservation (Wessels *et al.*, 2003; Lockwood, 1999). In addition, wildlife rich areas have a mosaic of land use/land cover such as grassland or grazing land interspersed with cropland and woodland, providing habitat for wild and domesticated herbivores, gathering and hunting for wild resources and eco-tourism (Homewood, 2004; Seno and Shaw, 2003).

It is widely recognised that the economic and social factors leading to the transformation of the wildlife habitats, especially in Africa, are as complex and diverse as the needs of the communities involved, hence the difficulty in reversing the trend (Darkoh, 2003). As Thornton *et al.* (2003) observed, the establishment of an appropriate balance between food security and conservation of natural resources that is consistent with wildlife conservation and the co-existence principles remains elusive. In addition, conventional agriculture is failing to meet the expectations and needs of the people who depend on it as compared to biodiversity as an alternative land use (Walker, 1999). Consequently, the overriding challenge is to devise ways and means to contain the spread of agriculture into protected areas whose boundaries are so fluid (Srivastava *et al.*, 1996.)

2.2 Wildlife and agriculture

The success of conservation in landscape shared between people and wildlife depends upon the relationship between them. Contrary to the general expectations of accrued economic benefits (Western and Wright, 1994), such landscapes have been characterised by heavy losses especially to rural peoples in the African continent (Naughton-Treves, 1998). Such losses have been the bedrock of discontent⁶ and conflict between conservation, wildlife and rural communities who bear the real cost of conservation without obtaining any significant benefits from it (Alcorn, 1993).

While the pressure to convert wildlife habitats to other land uses is driven by human population growth rates as well as in-migration, the impacts of rising wildlife, especially elephant, densities on the ecosystem pose great concerns because of their large and varied diet, physical impact on their surroundings, and high mobility (Mendelssohn, 1999; Kiiru, 1995; Kangwana, 1995; IUCN, 1998; Smith and Kasiki, 2000). High herbivores densities have significantly altered the ecosystems in East Africa through migration and search for forage and water. Incidentally, most farms are found situated near watering points that are also used by elephants and are easily invaded by elephants (Allaway, 1981). Consequently, elephants and people compete for space, water and vegetation (Hoft and Hoft, 1995)

⁶ These occur in the forms of political unrest, sabotage of conservation efforts and programs or projects, and disregard of laws aimed at conserving biodiversity (Tisdell, 1995)

Due to the diversity of and conflicting interests between wildlife conservation and rural livelihood (Homewood, 2004), most herbivores, especially the elephants, have been perceived as pests (IUCN, 1998; Sitati *et al.*, 2003). HEC is prevalent in virtually all elephant ranges worldwide, but more pronounced in agricultural areas adjacent to parks or reserves. However, the nature and magnitude of HEC is country specific and is determined by human population growth rates, conservation activities and availability of critical natural resources such as land and water. Today HEC is blamed for economic woes of small scale farmers across African and Asian elephant ranges. It is clear that such impacts must be minimized if elephant conservation is to succeed in African countries facing harsh socioeconomic realities.

2.3 Human-elephant conflict

2.3.1 Background

The African elephant (*Loxodonta Africana*) is the largest living land mammal. Described as charismatic, intelligent, social, long-lived, strong and very large, the African elephant displays a complex relationship with humans. While the elephant is used as a flagship species to gain public sympathy for species and habitat conservation, for example the African Wildlife Foundation logo, the negative emotions it evokes among subsistence farmers and pastoralists depicts the threat it poses to people's livelihoods and lives (Lee and Graham, 2006).

Records have shown that, the African elephant inhabited most of the African continent. However, the vast ranges have since shrunk, effectively confining the elephants to the south of the Sahara desert (Plate 1) (Said *et al.*, 1995).

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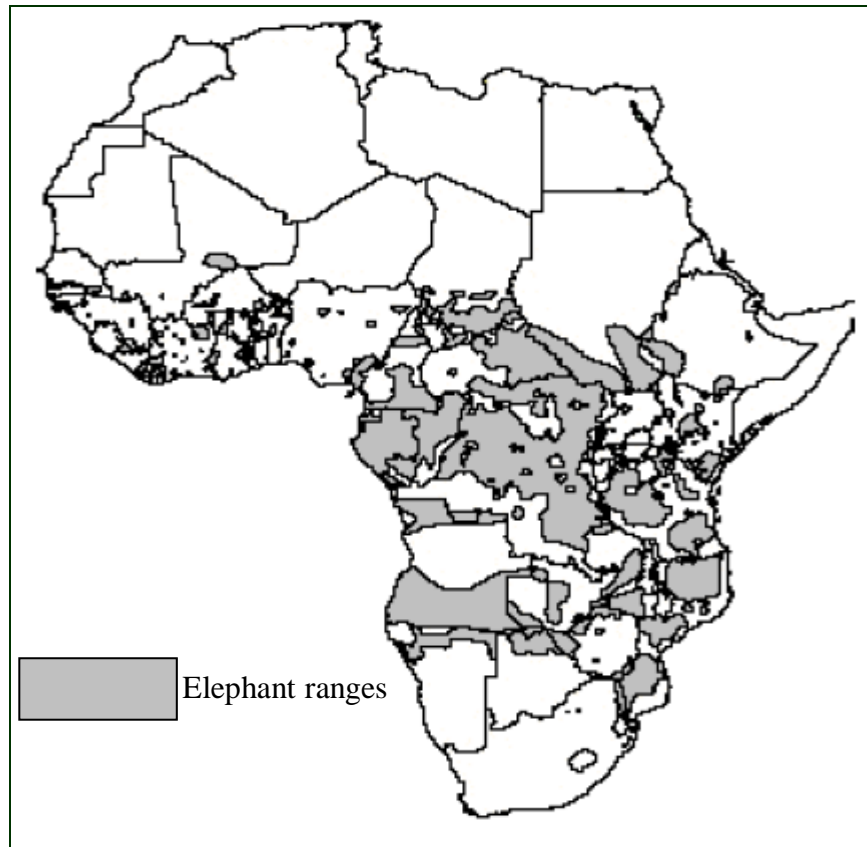


Plate 1: The distribution of the African elephant (Smith and Kasiki, 2000)

The proponents of the ivory trade theories hypothesise the role of ivory hunters in the extirpation of elephants in most parts of the continent, citing ‘competitive exclusion’ principle as the benchmark of their argument (e.g. Milner-Gulland and Beddington, 1993; Soule, 1987; Thomson, 1985; Hohnel, 1894; Newmann, 1989). On the other hand, increase in human population, expansion of settlements and agriculture is blamed for the habitat fragmentation and loss leading to local extinctions of African elephants (Parker and Graham, 1989; Barnes *et al.*, 1991; Child, 1995).

2.4 Human-elephant conflict in Africa

HEC has been defined as any and all disagreements or contentions relating to destruction, loss of life or property, and interference with rights of individuals or groups that are attributed directly or indirectly to elephants (KWS, 1994). HEC is not a new phenomenon in the Africa. Metaphorically, the Pleistocene African landscape has been likened to the small scattered human settlements (Islands) existing in a sea of elephants (Parker and Graham, 1989). It is assumed that

elephants heavily impacted upon cultivation in the pre-colonial Africa (Parker and Graham, 1989; Barnes, 1996; Hoare, 1999a).

In the colonial Africa, HEC was managed through elimination of problem animals (Swynnerton, 1923). Besides, the high value of elephant ivory in the colonial Africa provided an incentive to shoot any elephant that was perceived as a threat to human life and property (Hanks, 1979; Eltringham, 1990). In addition, local farmers are reported to have formed large, well defended villages to reduce crop losses to elephants and increase security (Laws *et al.*, 1975). According to Clutton-Brock, (1999), the wide stone walls surrounding ancient villages in Zimbabwe might have been used to deter crop raiders. Similarly, records of abandoned subsistence farms in Zambia and Malawi (Bell, 1984) are linked to the vulnerability of pre-colonial African farmers. In addition, Barnes (1996) suggests that elephants might have diminished farming prospects in the equatorial guinea, a position supported by existing colonial records of small scale farmers suffering extensive losses to elephants (Schweitzer, 1992)

The initiation of the Human-Elephant Conflict Task Force in 1997 by the IUCN's AEFSG and subsequent change to the Human-Elephant Conflict Working Group in 2002 in response to the increasing HEC in Africa was in recognition of the critical role of NGOs in setting management policies and implementation, resource use, monitoring, provision of financial and human resources and lobbying for change (Wells, 1998). Today, HEC practitioners grapple with the question of; why does HEC appear to be on the increase despite massive decline in African habitats and increased local big game extirpations, hence, reduced geographical range of human elephant contact (Hoare, 1995)? Increase in HEC is thus, linked to the changes in elephant and human ecology, especially, the changes to people's lifestyle that has reduced tolerance to elephant presence and damage (Naughton-Treves *et al.*, 1999).

2.5 Factors increasing HEC in Africa

Land use changes, human induced changes to elephant behaviour and socio-ecology, socio-economic and political changes in human society (Naughton-Treves *et al.*, 1999) are largely considered responsible for the increase in HEC. Agricultural extensification, and ventures into new environments (some of which are marginal and previously occupied by wildlife) both voluntarily and state-sponsored have put farmers and elephants in competition for space and food

Barnes, 1996; Campbell *et al.*, 1999; Gachago and Waithaka, 1995; Kiiru, 1995; Tchamba, 1996, Thouless, 1994; Thouless and Sakwa, 1995; Western, 1997).

Poaching and habitat loss have ‘crammed’ elephants into smaller areas leading to localised high densities and hence localised crop raids (Barnes *et al.*, 1995; Naughton-Treves, 1998; Sukumar, 1990; Sutton, 1998; Thouless and Sakwa, 1995). In addition, settlements on migratory corridors, maintenance of artificial water sources (Sukumar, 1990; Sutton, 1998; Thouless, 1994) and other activities like logging attract elephants closer to humans (Lahm, 1996; Sam, 1999) leading to aggressive behaviour by elephants and increase in conflicts.

The elephants’ persistence, intelligence and ability to habituate to virtually any form of intervention is strongly linked to the CITES ban on ivory trade and the sustained anti-poaching campaign which Kangwana (1995), Naughton-Treves (1998) and Tchamba (1996) hypothesise might have lead to loss of fear for humans. Tchamba (1996) further argues that elephants displaced by human encroachment are pushed closer to human settlements and hence access to crops. Furthermore, adaptively, elephants in areas of intense culling conglomerate into large herds that tend to cause massive damage to vegetation and crops (Southwood, 1977).

The centralized wildlife management has drastically reduced tolerance to elephants in many communities (Naughton-Treves, 1997; Western, 1997; Hart, *et al.*, 1998) as shown by the levels of complains. Similarly, private land ownerships have eroded traditional communal farming strategies effectively shifting responsibility for crop defence to individuals (Agrawal, 1997; Bell, 1984). Consequently, many farms have been abandoned and communal crop defence ignored (Lahm, 1996). Rural-urban migration in search of livelihoods, especially by men (Lahm, 1996) has rendered the women and children vulnerable, besides, children attend schools and hence, are passively involved in crop defence (Goldman, 1996).

In nearly all the elephant ranges in Africa, HEC has been reported with devastating implications (Hillman-Smith *et al.*, 1995; Lahm, 1996; Tchamba, 1996). However, the increase in reported HEC in the last few decades (Kangwana, 1995) is probably only partly due to the new interest in HEC and the increased human-elephant interface. Interestingly enough, most of these reports have had little or no evidence of increased incident severity other than hot spots (Hoare, 1999a).

Chapter Three

HEC in Kenya

3.1 Introduction

Kenya has a total area of 584,000 km² of which 7.5% is under PAs status either as NPs managed by the KWS or NRs managed by the local district councils⁷ (KWS, 1990). However, the KWS is the government organisation mandated to manage the country's wildlife resources including all the NPs and NRs. With more than 70% of Kenya's wildlife outside PAs (KWS, 1994), HWC is inevitable. Indeed, the KWS has focused particular attention to the protection of elephants through relevant action plans and policies which include anti poaching campaigns (Plate 2) to enhance their survival (KWS, 1991a; 1991b; 1996).

Following the CITES ban on ivory trade in 1989 (Berger, 2001), African elephant (*Loxodonta africana*) was moved to the Appendix I⁸ of the IUCN (Dobson, 1992; Mendelssohn, 1999). Consequently, elephant population increased across the continent with over 27,000 elephants in Kenya (Berger, 2001). Kenyan elephants are found in both savannah (Tsavo ecosystem and the Samburu and Laikipia districts) and forest (Aberdare and Mt. Kenya) ranges (Blanc *et al.*, 2007). Although baboons and monkeys rank higher among the problem animals in Kenya (KWS, 1994), elephants constitute a major threat to people since they destroy large area of crop, kill people and the segment of the society affected usually has low economic resilience. The HEC in Kenya is widespread but more severe in areas of intense agriculture bordering NPs and NRs (Kiiru, 1995) and on private land (Muriuki, 2007).

Economic losses to agriculture, especially loss of cattle, crops, breaking of grain stores, water reservoirs and barriers (Plate 3a, b, c and d) are common in Kenya (Hoare, 1999a; Thouless,

⁷ Local councils have the mandate to manage wildlife within the district boundaries but with very close consultation with the KWS. This is because all wildlife is state owned and hence their management and conservation on all lands in Kenya is the responsibility of the KWS by law (Kinyua *et al.*, 2000)

⁸ **Appendix I** lists species that are the most endangered among CITES-listed animals and plants. They are threatened with extinction and CITES prohibits international trade in specimens of these species except when the purpose of the import is not commercial, for instance for scientific research. Authority to do so must, however, must be granted (CITES, 2008).

1994). However, people have been killed in an attempt to defend their crops (IUCN, 1998; Smith and Kasiki, 2000; Hoare, 1999a; Kangwana, 1995; Kiiru, 1995).



Plate 2: Burning ivory in Nairobi National Park, Kenya, 1989⁹ (KWS, 1996).

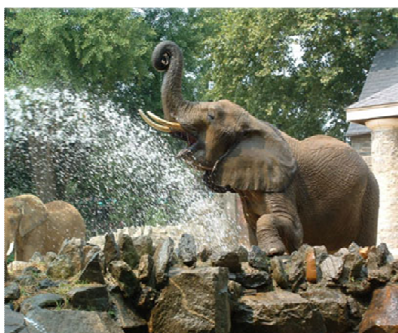
a)



b)



c)



d)



**Plate 3: a) A cow gored by elephant,
c) Elephants drinking from a broken water pipe,**

**b) A trail of elephant destruction in a maize farm,
d) A grain store broken by elephants.**

⁹ Following the 1977 presidential decree banning all hunting all wild animals to curb poaching

Between January 1989 and June 1994, 448 people were killed by wildlife, of which elephants were responsible for 173 incidents (KWS, 1994). In addition, at least 15 elephants were killed in conflicts in Kilimanjaro between 1996 and 1997 (Muruthi *et al.*, 2000). Similarly, out of the 437 elephant mortalities reported in Amboseli between 1974 and 1990, 141 were killed in conflicts (Kangwana, 1993) using arrows and spears.

a)

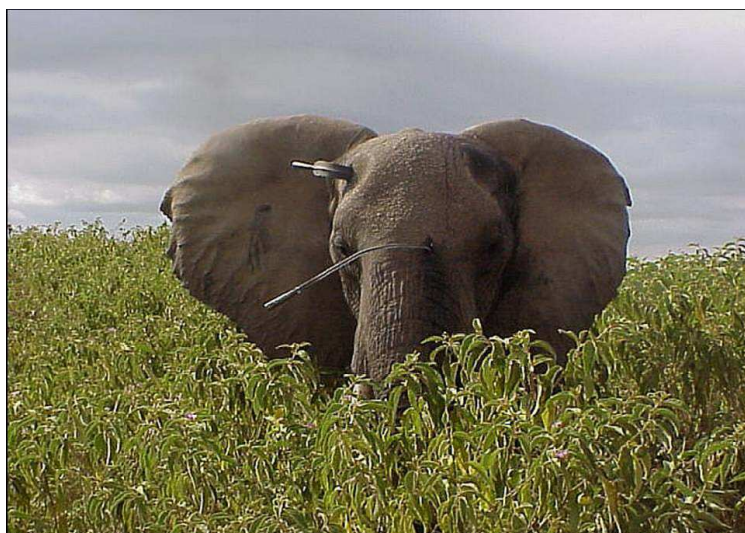


Plate 4: An elephant speared in conflict mitigation

b)



Elephant carcass left in a maize field

Other socio-economic costs to the local people (WWF, 1997) include restrictions on movement, school absenteeism due to the need to guard crops, loss of sleep due to fear, unemployment, increased exposure to malaria and psychological stress (Plate 5a and b) (Hoare, 2000; Naughton-Treves *et al.*, 1998). Similarly, elephants disrupt social functions like schools, markets and religious functions (Thouless, 1994; Newmark *et al.*, 1994).

a)



Plate 5: School absenteeism and Psychological stress

b)



Restriction on important functions

Interestingly, the local farmers recognise the increased elephant population due to protection, and hence loss of fear for humans, choosing to venture close to people's settlement to forage. Furthermore, they feel the government value elephants more than people by their reluctance to remove problem elephants (KWS, 1994).

3.2 HEC management in Kenya

HEC mitigation in Kenya has evolved from the traditional centralized avoidance and force approach to a more proactive, inclusive and research based approach. Prior to the formation of the KWS in 1992, the WCMD, through an array of legal provisions used bureaucratic measures and tactics in dealing with HEC, hence, more discontent not only with the 'pest' species but also the WCMD (KWS, 1994). Today, the KWS has taken steps to reduce HEC through long term measures such as electrified fencing, translocation, shooting problem elephants, active research and policy reviews. In 2003, the KWS undertook a country wide wildlife policy review, with a focus on national elephant conservation strategy in 2005 (Blanc *et al.*, 2007). Traditional and Conventional techniques are commonly used in HEC mitigation in Kenya. However, research-based 'Experimental techniques' are currently being tested in many parts.

3.2.1 Traditional techniques

The traditional techniques are self defence measures by farmers to protect their crops from elephants (Hoare, 2001) usually when and where the local authorities are not available. Many of these methods are as old as agriculture itself, but for economic reasons and uncertainties with the modern techniques, they are still widely used. The traditional methods are diverse, ranging from collective prayers and magic (Tchamba, 1996), erection of human effigies (Thouless, 1994) to hanging clothes and rags on trees (De Boer and Ntumi, 2001).

Crop guarding on observation towers with an alarm system and spotlight, shouting and noise to frighten elephants, lighting fires at the field boundaries or elephant corridors, air-borne missiles like stones, glowing tinder and spears and simple barriers using bark ropes or string with tins and cloth attached to them (Plate 6) have also been used (De Boer and Ntumi, 2001; Thouless, 1994). However, research results have pointed to little or no success in crop protection. Indeed, on several occasions, farmers have been killed while trying to chase away elephants (Thouless and Sakwa, 1995).

3.2.2 Conventional techniques

The conventional techniques are used by the wildlife authorities to supplement traditional methods and especially where elephants have habituated to the range of traditional techniques. These include thunder flashes, flash lights and flares (Nyhus *et al.*, 2000; Hoare, 2001), electrified fences alongside moats and trenches, shooting of elephants in PAC and translocation.



Plate 6: Simple fence barrier with tins attached to deter elephants (Emma Stokes, WCS-Congo)

According to Crawley (2001), in 1996 and 1999, 107 and 17 elephants were shot by the KWS, respectively, in PAC as a quick-fix to HEC and an act of retribution. PAC officials identify culprit which is shot at the scene of incident. That shooting does not reduce the number of HEC incidents (e.g. Tchamba, 1995; Tylor, 1993; Bitu, 1997) is an evidence of flaws and limited success (Hoare, 2001; Osborn, 1989)

Physical barriers including electrified fences, trenches and stone walls have been used in crop defence. Although many HEC practitioners believe they are the best strategy to deter crop raiders (Hoare, 2001b), studies in Laikipia indicated that, elephants learnt to break down the walls and climb the trenches along the Aberdare and Mt. Kenya boundaries, uprooted electrified fences and used their chests to bring down stone walls (Thouless and Sakwa, 1995). In addition, electrified fences are prone to vandalism and thefts by local people in search of grazing and are expensive to construct and maintain (Kangwana, 1995; Ngunjiri, 1995).

Although translocation provides short term HEC reduction and reduces elephant pressure on the environment and competition for resources (Hoft and Hoft, 1995; IUCN, 1998), it is widely viewed as a mere transfer of problems to other areas (Hart and O'Connell, 1998). In 2000, ten elephants were removed from Laikipia to Meru NP and three from Shimba Hills NR to Tsavo East NP in a logistically complex process (Litoroh *et al.*, 2001). Besides, Translocation is increasingly criticised for its ignorance of the welfare of the elephants in transit by animal rights groups (e.g., FFI, 2002; Hoare, 1999b; Njumbi *et al.*, 1996).

a)



Plate 7: Elephant translocation in Laikipia

b)



Section of the Ol Pejeta Electrified fence

3.2.3 Experimental techniques

There is evidence of constant innovation, creativity and changing approaches to human elephant conflict management across Africa (Hoare, 1995; Osborn and Parker, 2003) using specific olfactory and auditory repellents. Chilli (*Capsicum spp*) based deterrents, have been tested extensively in Zimbabwe (e.g. Osborn and Parker, 2002) and Kenya (e.g. Sitati and Walpole, 2006; Graham and Ochieng, 2008) with evidence of successful implementation in Ghana, Mozambique, Zambia, Botswana and Namibia (Hoare, 2001; Sitati and Walpole, 2006).

The methods, based on elephants' hate for chillies, include chilli fences, made from a mixture of grounded chillies and engine grease applied on sisal strings tied round the farm perimeter, and chilli-dung briquettes made from a mixture of grounded chilly and elephant dung (Graham and Ochieng, 2008; Sitati and Walpole, 2006). When burnt, the chilli-dung briquettes emit a noxious smoke that persists as a deterrent for up to four hours causing irritation to elephants (Muruthi, 2005).

a)



Plate 8: A chill fence in Mutara, Laikipia

b)



Set of dried chilli-dung briquettes

Auditory repellents are comprised of loud noise makers that cause discomfort to elephants especially when they are taken by surprise. In Amboseli, simple air pressure horns and fireworks such as ‘commando bombs’ (Plate 9a and b) have been used to frighten elephants before entering the crop fields.

a)



Plate 9: A set of ‘commando bombs’

b)



A farmer demonstrating using an air pressure horn

Different techniques like use of bees and GeoFencing (GPS/GSM-Based technology) are being tested in Transmara, Samburu and Laikipia. A growing body of evidence suggests that

experimental methods can greatly improve the success of subsistence farmers' defence against elephants (Osborn and Parker, 2002). However, few published studies exist (Graham and Ochieng, 2008). Furthermore, there is little evidence to show uptake by the wider pool of farmers, other than those participating in the trials (Sitati and Walpole, 2006).

Chapter Four

The study area

Covering a total of 9,700km², at 1700m-2000m above sea level in the north central Kenya, Laikipia district (Plate 10) comprises a plateau of undulating low hills and plains (800 to 1200m) along the equator. Laikipia is bound to the east by Mt. Kenya (5199m), south west by Aberdare highlands (3999m), Rift Valley escarpments to west and Samburu District, to the north (Graham, 2007).

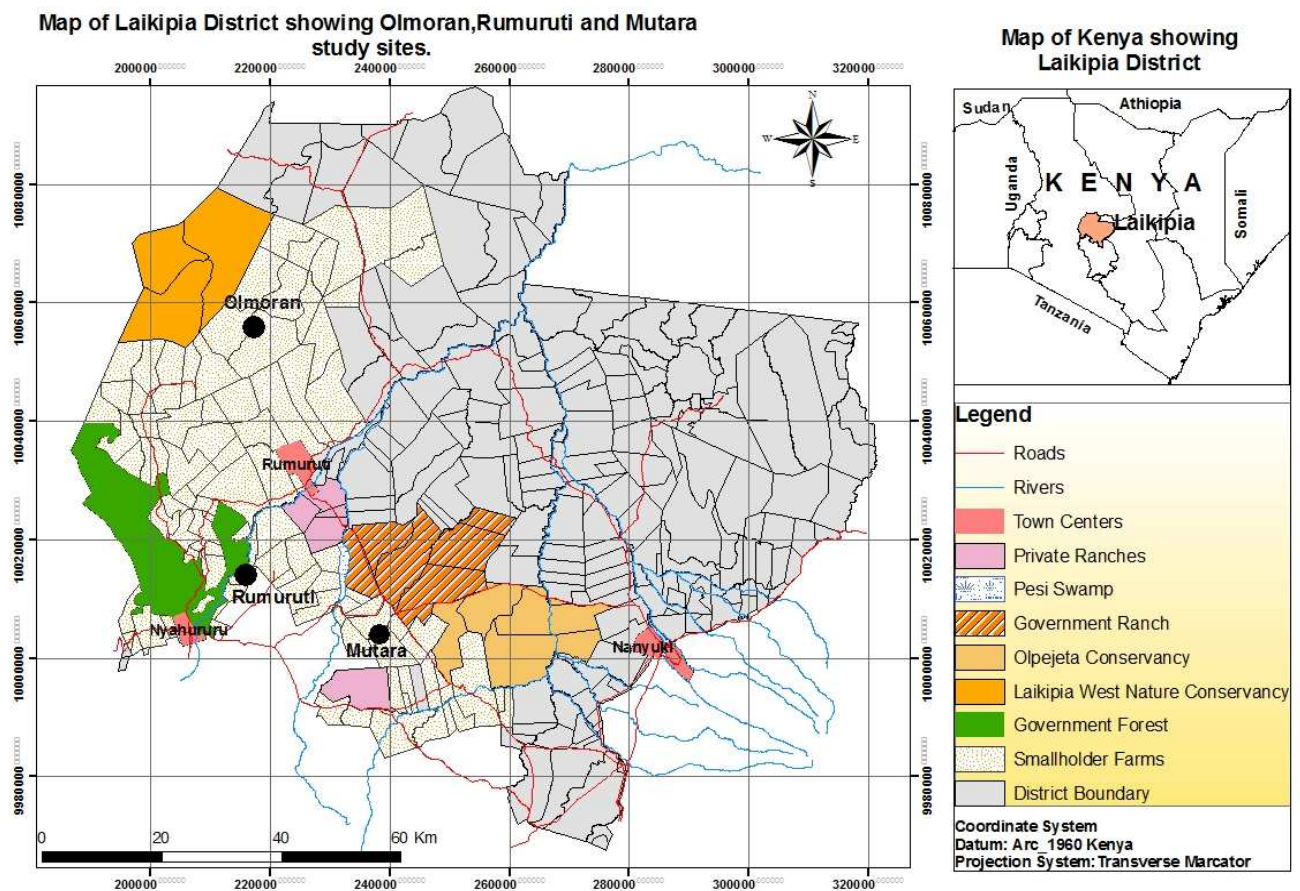


Plate 10: Map of Laikipia District, Kenya showing the location of the district and land uses. The three study sites in my study are labelled.

Laikipia has a distinct bimodal pattern rainfall pattern with peaks of long rains between April and June and short rains between October and December (Graham, 2007). The Mt. Kenya and the Aberdares have a strong influence on average annual rainfall distribution with a gradient of between 750mm and 300mm between the southern and the northern part of the district respectively (Plate 11) (Berger, 1989)

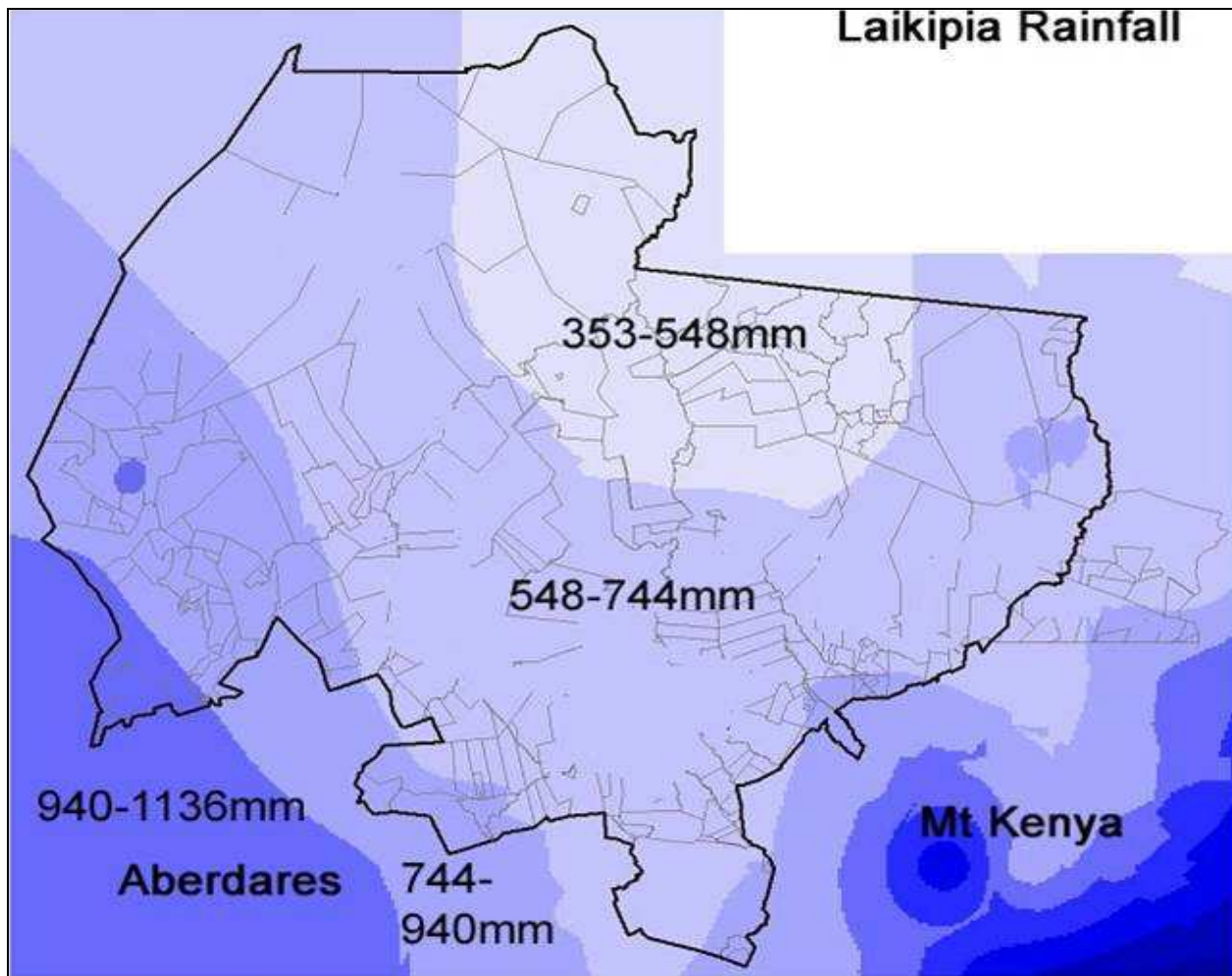


Plate 11: Rainfall distribution in Laikipia District (Graham, 2007)

Laikipia has a population of 310,000 people (Kiteme *et al.*, 1998). The population distribution is influenced by the availability of arable land and rainfall (Plate 12), hence, higher densities in the southern arable parts forcing people to settle in more arid and marginal areas (Thouless, 1994). Land in Laikipia exists under private, communal and government ownership. Large scale ranches of between 5,000ha to 100,000ha constitute some 42 % of the district while 37% is smallholder, of between 0.25ha to 5ha pieces carved out of the large ranches for settlement at Kenya's independence in 1963 (Thouless and Sakwa, 1995) and about 8% is communal ranches, forest, swamps and urban areas (Graham, 2007).

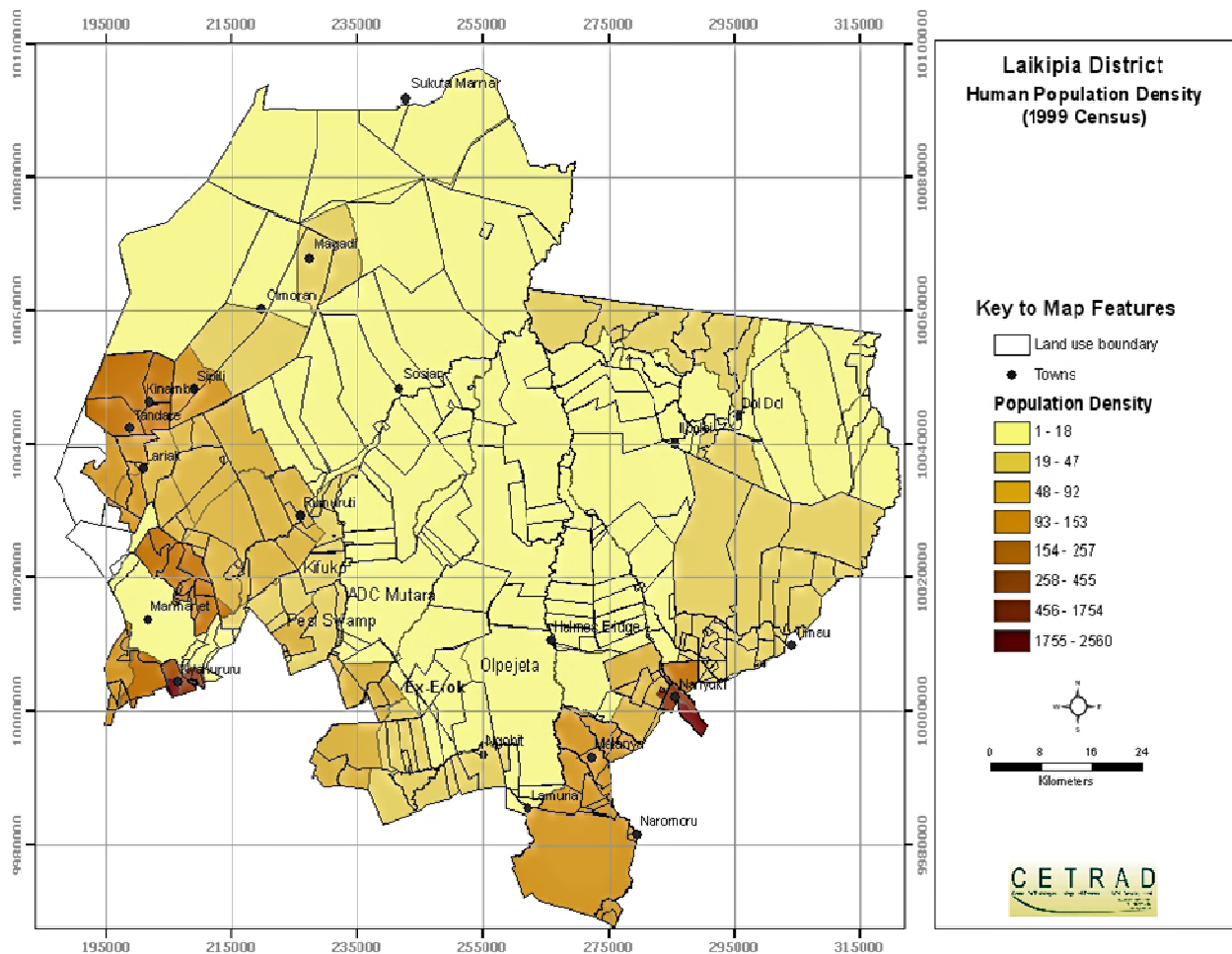


Plate 12: Map of Laikipia District showing population distribution

Source: CETRAD

In a typical ‘fortress’ model, the British government in 1904, after an agreement with the Maasai elders, relocated the Maasai from the central Rift Valley in exchange for Northern Maasai Reserve (Laikipia region) and Southern Maasai Reserve (Kajiado and Narok Districts) (Hughes, 2005). Following another agreement in 1911, the Maasai were relocated from the Northern Reserve to the expanded Southern Reserve to paved way for European settlement in Laikipia (Hughes, 2005). By the 1920s, the soldier settler scheme increased the number of European settlers within Laikipia (Kohler, 1987). Consequently, large estates ranging from 10,000ha to more than 30,000ha were created for beef production and hence increased land consolidation (Kohler, 1987). Today, large scale ranches with acreage of more than 90,000ha, such as Ol Pejeta and Ol Ari Nyrio (Laikipia West Nature Conservancy) still exist in Laikipia (Graham, 2007).

Due to population pressure in central Kenya and growing concerns over African land-rights that culminated in the armed 'Mau Mau' uprising, demand and struggle for land increased in Kenya at independence in 1963. Large scale ranches were purchased and subdivided through non-governmental land buying groups (cooperatives) on a willing buyer willing seller basis (Graham, 2007). This led to the decline in both plot size and cultivation potential of land hence, coupled with poor rainfall, plots were often abandoned (Huber and Oponde, 2005) and became opportunistically settled on by the pastoralist groups such as Pokot, Turkana, Samburu and Mukogodo Maasai.

The unplanned land subdivision and settlement effectively left many smallholder farms surrounded by ranches and forests with substantial wildlife populations (Kohler, 1987). Consequently, crop depredation and threat and death to people and livestock increased (Thouless and Sakwa, 1995; Gadd, 2005).

Chapter Five

Methodology

5.1 Site Selection

I worked with the Laikipia Elephant Project (LEP)¹⁰ from January 2005 to September 2007. This dissertation analyses data collected between October 2006 and October 2007 by LEP field enumerators under my supervision. Data collection protocol was overseen by Dr. Max Graham while I did the data analysis supervised by Prof. W. Adams.

Based on prior research results (e.g. Graham, 2007; Thouless, 1993), I selected three sites to study the HEC mitigation techniques in Laikipia. The study sites, of variable sizes, were systematically monitored between October 2006 and October 2007 by local enumerators to assess elephant damage. Two major criteria were used for the selection of the study sites.

- Firstly, the selection was based on the main land use types in the district namely: forest reserves, smallholder farms and large scale ranches (Figure 10 above). The forest reserves and large scale ranches provide refuge for elephants and are bordered by smallholder farms, hence, higher chances of HEC occurrence and inevitable use of deterrent techniques. As a result three study sites namely¹¹ Mutara, Olmorán and Rumuruti, were chosen within the wider Laikipia study area. Each of these study sites is briefly described below.
- Secondly, the selection was based a logistics and accessibility. The three study sites are strategically located within areas accessible by a motor bike or a bicycle (my major means of transport). The Rumuruti and Mutara sites are close to major town centres in Laikipia: Nanyuki and Nyahururu, hence availability of social amenities and communication, while Olmorán is at the far end of the district and provides a unique setting for investigation.

¹⁰ Laikipia Elephant Project (Appendix 1) is based in Nanyuki and at the Centre for Training and Integrated Research in ASAL development (Appendix 2)

¹¹ The study sites are named according to the government administrative boundaries, but the actual study coverage does not span the whole division due to logistical concerns. Between 5 and 10km² is covered in each study site.

5.1.1 Rumuruti

The Rumuruti site lies to the north of Nyahururu town. It is traversed by the Nyahururu-Ngarua road and the Ewaso Narok River and adjoins the Rumuruti forest; the second largest in Laikipia District covering 6,337ha with a large migrant and resident elephant population. The site consists of Lorian, Salama, Gatundia, Makenzi and Sironi (Plate 13). Rumuruti has a high mean annual rainfall of about 700mm/y with the long rains between April and August and the short rains in November (Kihia and Chanzu, 1982).

Salama is a high agricultural potential land while most of the land around the Rumuruti forest edge is medium potential (Jaetzold and Schmidt, 1993) favouring subsistence farming and cattle herding. Agriculture is rain-fed; major crops are maize, beans, potatoes, millet, sorghum, cassava, sweet potatoes, wheat and peas (Wafula, 1997). Other activities include illegal charcoal burning, domestic bound logging, and illegal honey hunting. These have contributed to increased forest fires and reduction in forest cover (Kyego, 1998) leaving a narrow corridor joining the Marmanet Forest Reserve and the Rumuruti forest (Plate 13). HEC is reported at the smallholder farms and forest interface.

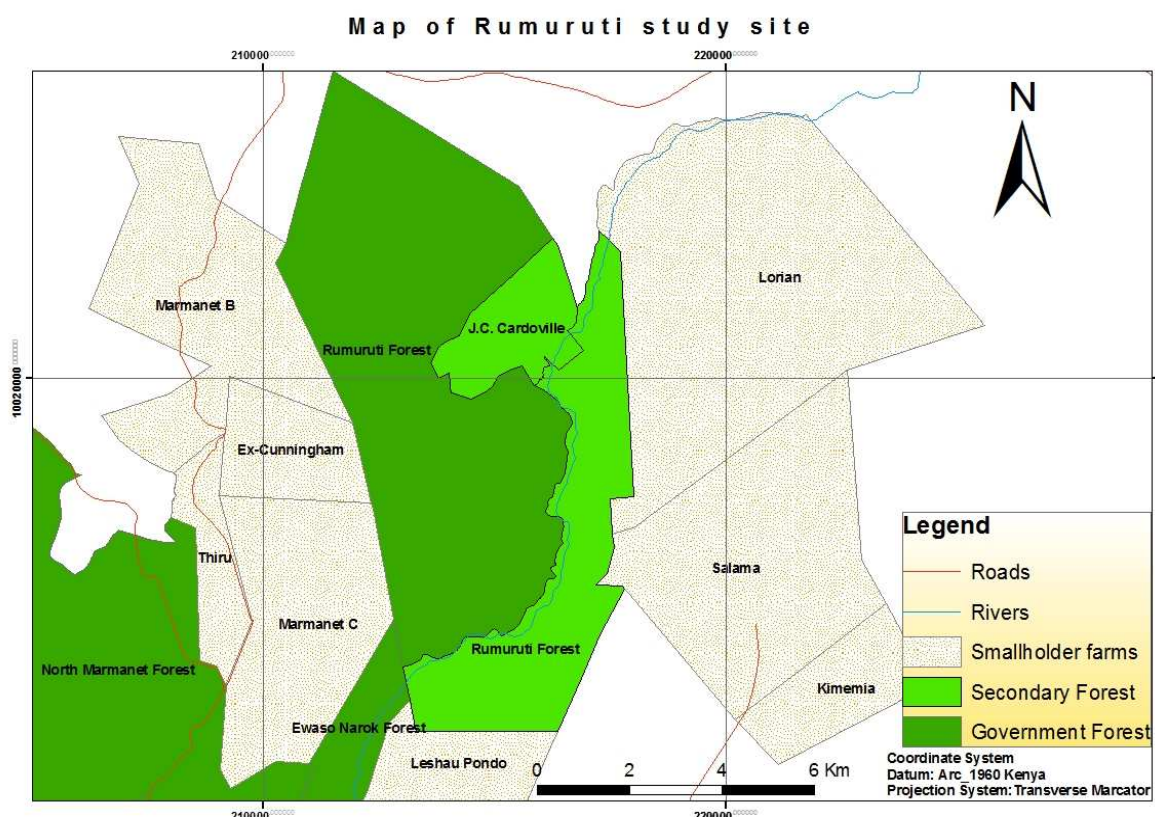


Plate 13: Rumuruti study site and the government forest

The Marmanet B and C, and the Ex-Cunningham areas are not part of the Rumuruti study site (see footnote 2). They are, however, part of the newly created Marmanet study site by the Laikipia Elephant Project 2007/2008.

5.1.2 Mutara

The Mutara study site is located about 60km west of Nanyuki town and 30km north of Nyahururu town in central Laikipia. It is linked to the two towns by the Nanyuki-Rumuruti and Nanyuki-Nyahururu roads and lies close to the Pesi swamp. The site consists of Ex-Rok and Kiamariga (Plate 14). Agriculture is both rain-fed in Ex-Erok and irrigated in Kiamariga. Crops, including tomatoes, cabbage, potatoes and vegetable are grown throughout the year.

The Mutara site is bordered to the east by the Ol Pejeta Conservancy, to the north by the ADC Mutara and to the south by large scale private farms (Plate 14). The Ol Pejeta conservancy occupies approximately 360km², and hosts a large population of elephants within an electrified fence enclosure. The ADC Mutara is a government ranch, established by an Act of Parliament in 1986 to promote agricultural schemes and reconstruction in Kenya. Although it tolerates wildlife, wildlife protection is not its priority. It uses a standard livestock fence which does not deter elephants. HEC, especially crop raiding, is reported throughout the year.

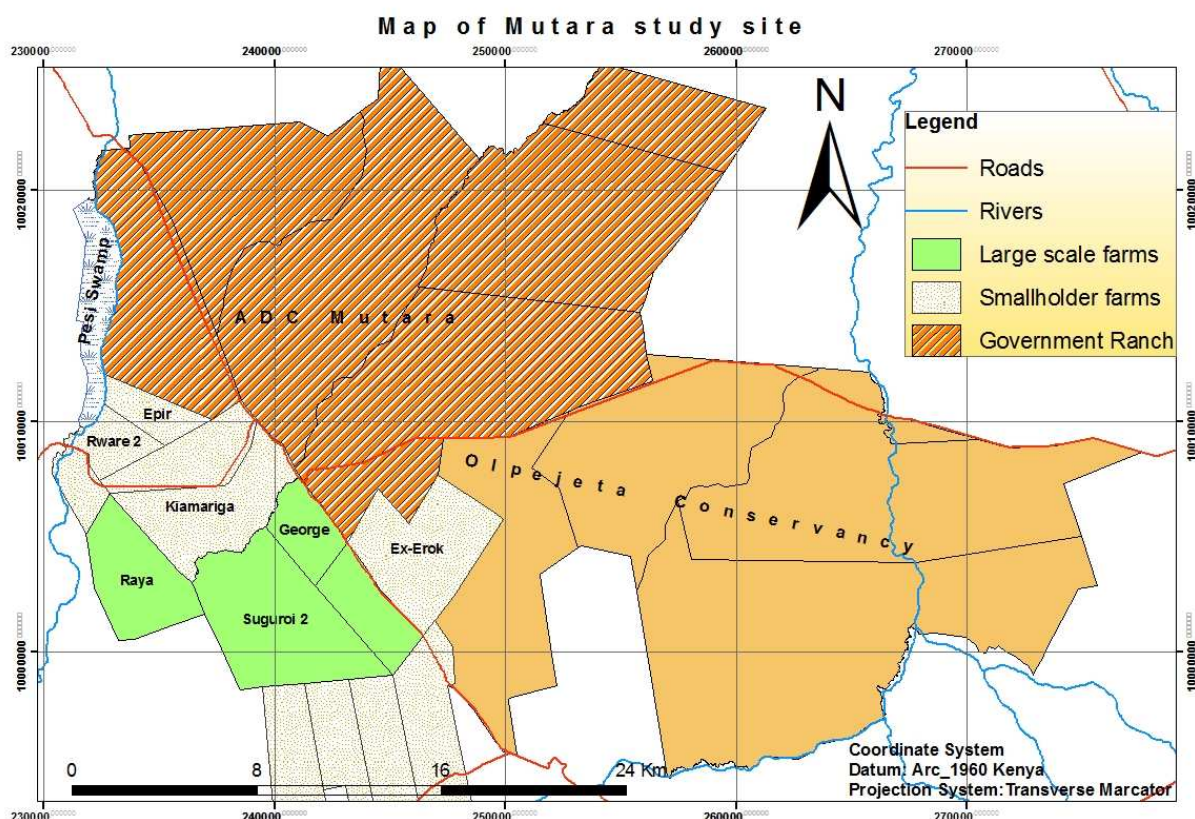


Plate 14: Mutara study site showing elephant refuges

5.1.3 Olmoran

The Olmoran study site, located in the south west of Laikipia District with a total of 2,000 acres curved out of the wider Laikipia West Nature Conservancy for smallholder agriculture is dominated by the pastoralist Samburu and Pokot tribes. The site consists of Laikipia West and Mutukanio areas (Plate 15).

Unlike Rumuruti and Mutara, Olmoran has poor roads that are frequently washed away during heavy rains and no permanent rivers hence reliance on boreholes and dams water. Agriculture is rain-fed but rains are unreliable hence crop failures (Plate 16a). Major crops are maize, beans, potatoes, sweet potatoes, and peas. Other activities include illegal charcoal burning and pastoralism.

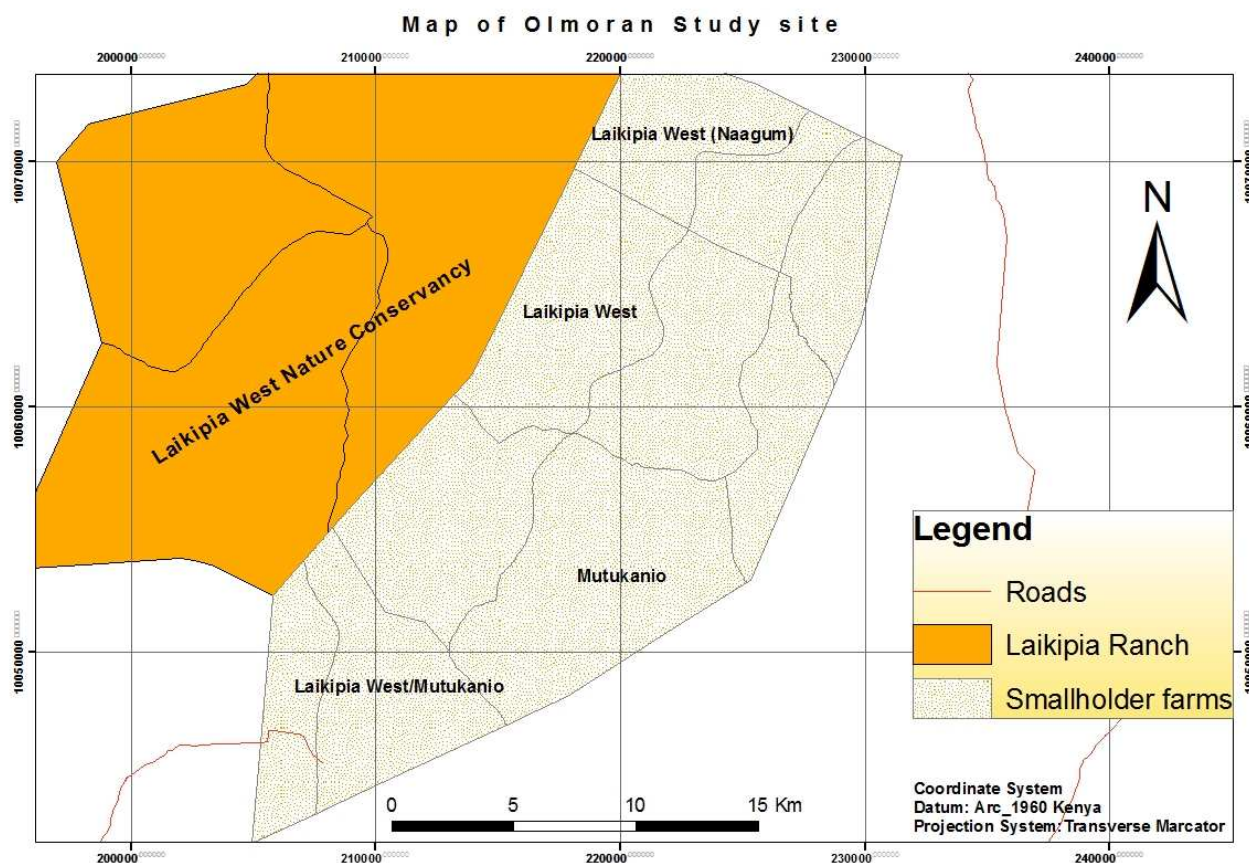


Plate 15: Olmoran study site and Laikipia West Nature Conservancy

The Olmoran site is bordered by the Laikipia West Nature Conservancy to the west. The Conservancy, considered ‘the most botanically diverse non-forested area in East Africa’ (Young, 1989), is a private wildlife sanctuary covering over 98, 000ha with at least 62 man-made lakes that

attract large herds of elephants (Gallmann *et al.*, 2008). It hosts the largest population of Cape buffalo outside National Parks as well as huge herds of elephants.



a)



b)

Plate 16: Olmorani has low rains, poor soils and bad roads

The conservancy is secured by an electrified fence, erected in 1980, to protect the smallholder farms from elephant incursions (Thouless and Sakwa, 1995). However, due to poor maintenance and elephant population pressure, the fence is ineffective hence HEC is reported.

5.2 Data collection and analysis

5.2.1 HEC data

Under the supervision of Dr. Max Graham, I recruited ten enumerators from HEC ‘hot spots’ in Laikipia and trained them in data collection (Plate 17) using the IUCN’s training package for enumerators of elephant damage and a standardized data collection protocol (Hoare, 1999b). The enumerators visited farms within their study sites daily to estimate the cultivated crop area planted and damaged crop area, crop type damaged, crop stage (seedlings, interim or mature), deterrent used and crop quality at the time of incident. They also recorded farm location using a GPS unit in UTM coordinates (Plate 18). All these were recorded in a standardized HEC reporting form (Appendix 3).

I visited each enumerator on a monthly basis, spending on average, 20 days on a motorbike, to collect the current datasheets, discuss recent events, check the GPS units and verify the accuracy

of the enumerators' HEC assessments. The costs, which included motorbike fuel and maintenance, field allowances and enumerators' monthly salaries, were provided by the Laikipia Elephant Project. The enumerators visited the project office in Nanyuki once to deliver HEC monitoring forms during the first week of the month.



Plate 17: HEC enumerators during a training session at CETRAD, Nanyuki (Graham, 2007)



Plate 18: HEC enumerator filling in forms, the Project director (Graham) and a local farmer looks on. Behind them is a space along the fence that was ripped open by elephants the previous night.

All the monthly HEC data was entered in the Laikipia HEC database. I used the 2006/2007 HEC data (2086 incidents) for my study which was analysed using SPSS 13.0 for windows (SPSS, 2007) at the study site level (5 to 10 km²) and the Windows Microsoft Excel, 2003.

5.2.2 GIS Data and Sources

A GIS provides a means of spatial data storage as a series of digital maps called coverage, each describing different information about the same study site (Smith and Kasiki, 2000). GIS provides a system for the management, analysis, and display of geographic information (ESRI, 2004) in two formats:

1. Vector coverage: These data represent space as a series of point, line or polygon units.
2. Raster coverage: These data represent space as a grid of equally sized squares with each square containing a numeric value that may represent membership of a particular group/classification such as grassland or the quantitative value for a phenomenon measured at that point such as percentage of cultivation (Graham, 2007).

While attempts were made to generate as much GIS coverage data as possible on my own through field work, using the GPS units (model Garmin GPS 12) and the ArcGIS 9.2 software, some data layers were obtained from online databases and personal communication with the Kenyan based GIS research institutions such as CETRAD¹² and ILRI¹³ and published sources. The data layers were made available through Dr. Max Graham. However, I created all the figures and maps of the study sites and HEC distribution except where otherwise acknowledged. These included:

Data layer	Source
Boundaries	CETRAD GIS and ILRI GIS Databases
Road and river vector files	CETRAD GIS Database
HEC incidents distribution	Enumerators' GPS survey and personal layer generation and manipulation in ArcGIS 9.2
Land use layers	CETRAD and personal manipulation in

¹² The Centre for Training and Integrated Research in ASALs Development is based in Nanyuki, Kenya, and was my employer, hence access to data, training and software (Appendix 2).

¹³ The International Livestock Research Institute is based in Nairobi, Kenya. ILRI runs a free online GIS database availed to students and researchers.

	ArcGIS 9.2
Population distribution layers	CETRAD GIS Database
Rainfall distribution	CETRAD GIS Database

Table 1: GIS data and sources

This methodology undoubtedly, enhanced the credibility of data presented in this dissertation rendering this HEC study authentic.

Chapter Six

Results

6.1 HEC types in the study sites

Out of the total 2086 HEC incidents in Laikipia, crop raid ($\geq 65\%$) and barrier damage ($\geq 25\%$) were the dominant forms of HEC. Mutara recorded the highest incidents (>1300) while Rumuruti had the lowest incidents (<400). There was 1 case of human death involving a lone male elephant during crop defence in Olmorani (Table 2), representing $<0.05\%$ of the reported incidents (Figure 1).

HEC Incident types by study sites					
	Crop Raiding	Structure Damage	Barrier Damage	Human Casualty	Livestock Loss
Mutara	1223	3	151	0	0
Rumuruti	223	24	133	0	0
Olmoran	396	2	540	1	0
Totals	1842	29	824	1	0

Table 2

Most smallholder farms were fenced by simple barriers which elephants broke through to get to the farms. Structural damage, especially to grain stores, was reported in Rumuruti during dry season when most of the produce was in the compound (Figure 1).

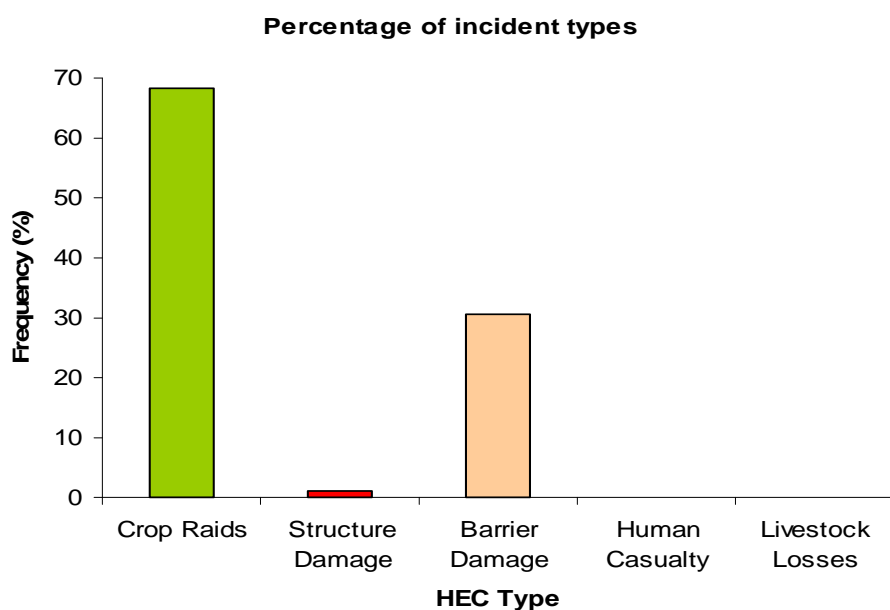


Figure 1: HEC types in Laikipia

6.2 Overall HEC patterns

6.2.1 Temporal patterns

The temporal distribution of HEC incidents reflected the physical variations in the three sites. There was an overall co-relational trend in HEC occurrence to rainfall pattern in Laikipia (Figure 3). In Rumuruti and Olmorán, HEC peaked in October and November (≥ 80) and June and July (≥ 78), while In Mutara, incidents peaked in April (≥ 170) and September (≥ 150), but remained highest throughout the year (Figure 2a, b and c).

Figure 2: Monthly HEC distribution in Laikipia

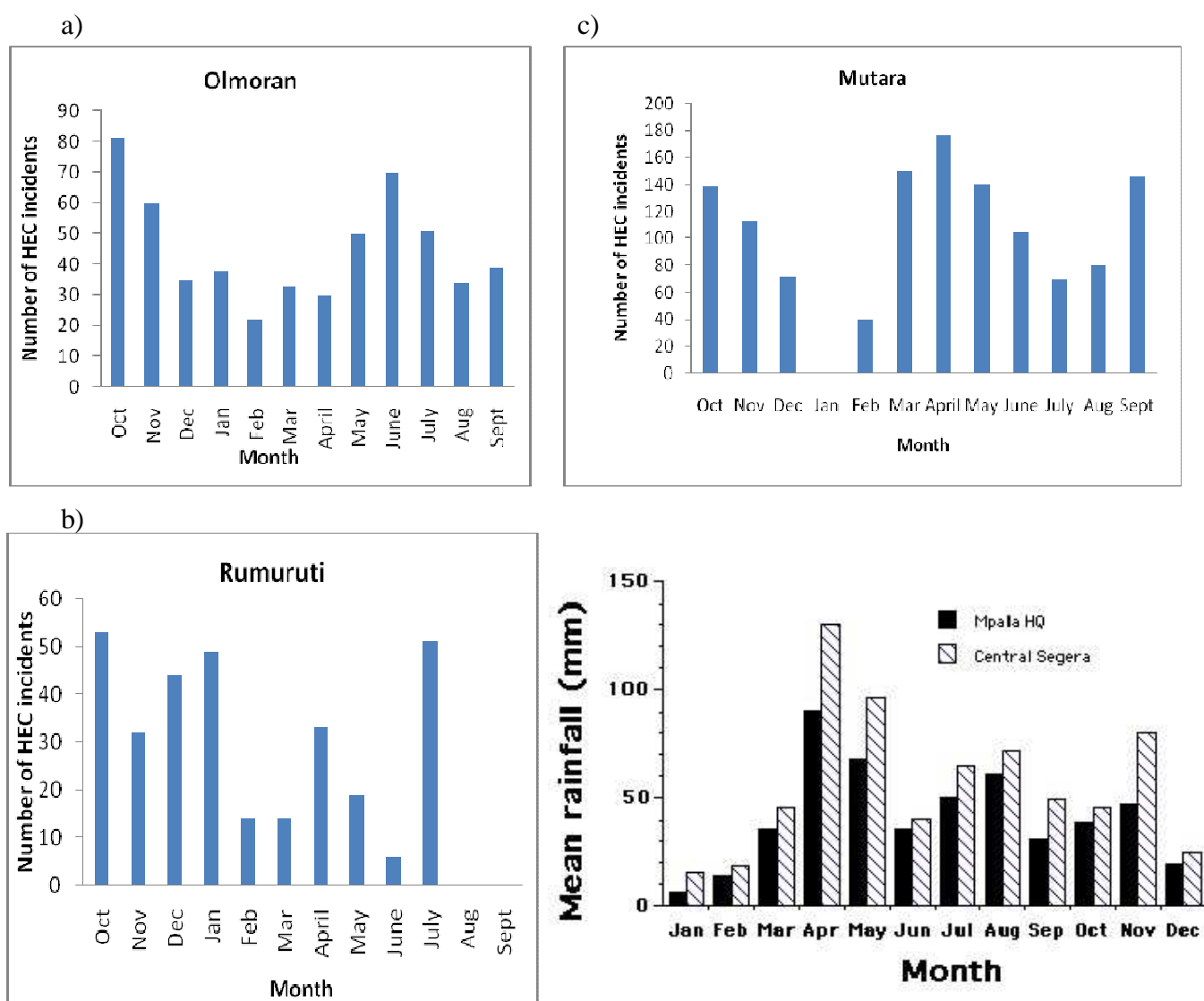


Figure 3: Monthly rainfall distribution in Laikipia (Mpala Research Centre, 2005)

Most incidents were reported during the night especially between 11PM and 2AM in all the three study sites (Figure 4). However, some infrastructure damage occurred during the day.

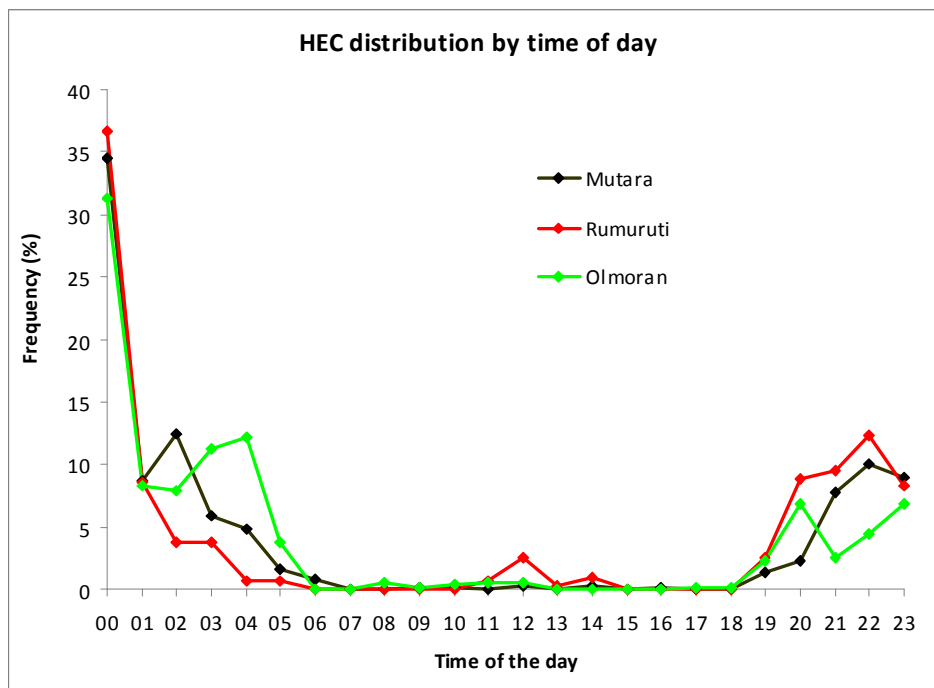
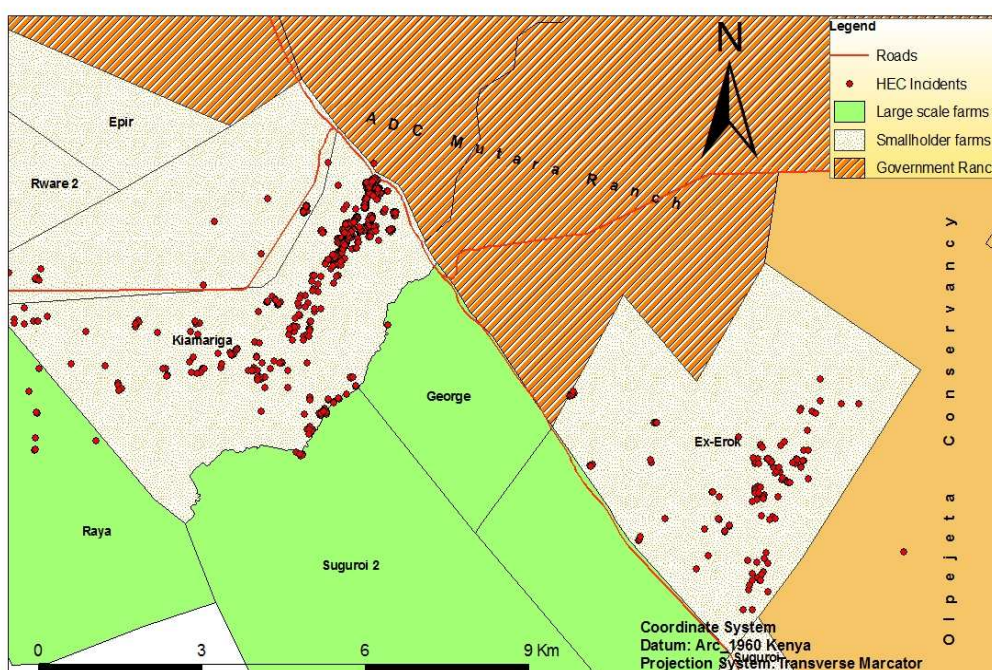


Figure 4

6.2.2 Spatial pattern

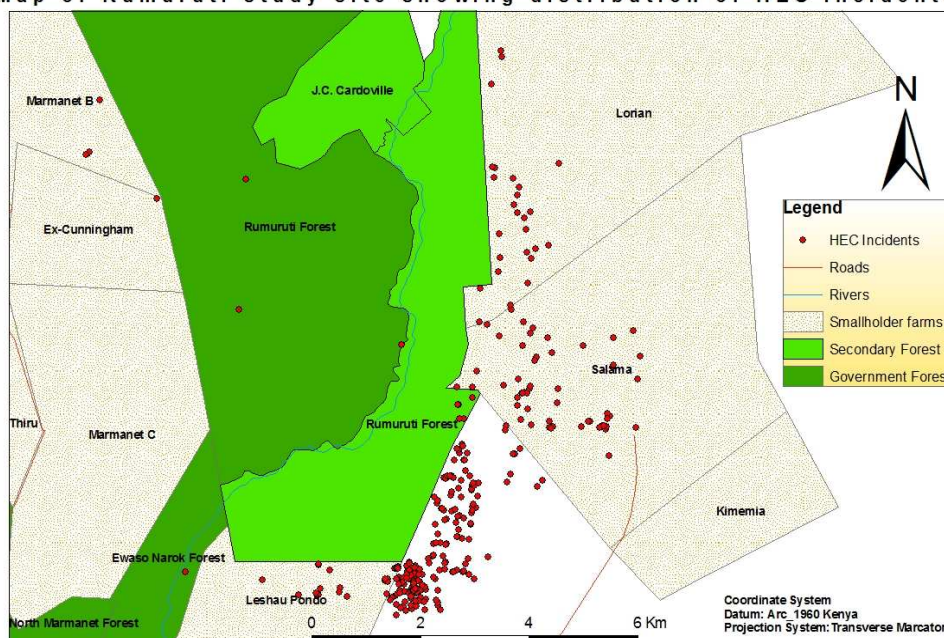
HEC was spatially clustered within the cultivated farms at Kiamariga and Ex-Erok. Ol pejeta conservancy and ADC Mutara Ranch provided elephant refuges while the large scale private farms nearby provided hiding for elephants very close to the smallholder farms in Mutara (Plate 19).

Plate 19: Map of Mutara study site showing distribution of HEC incidents



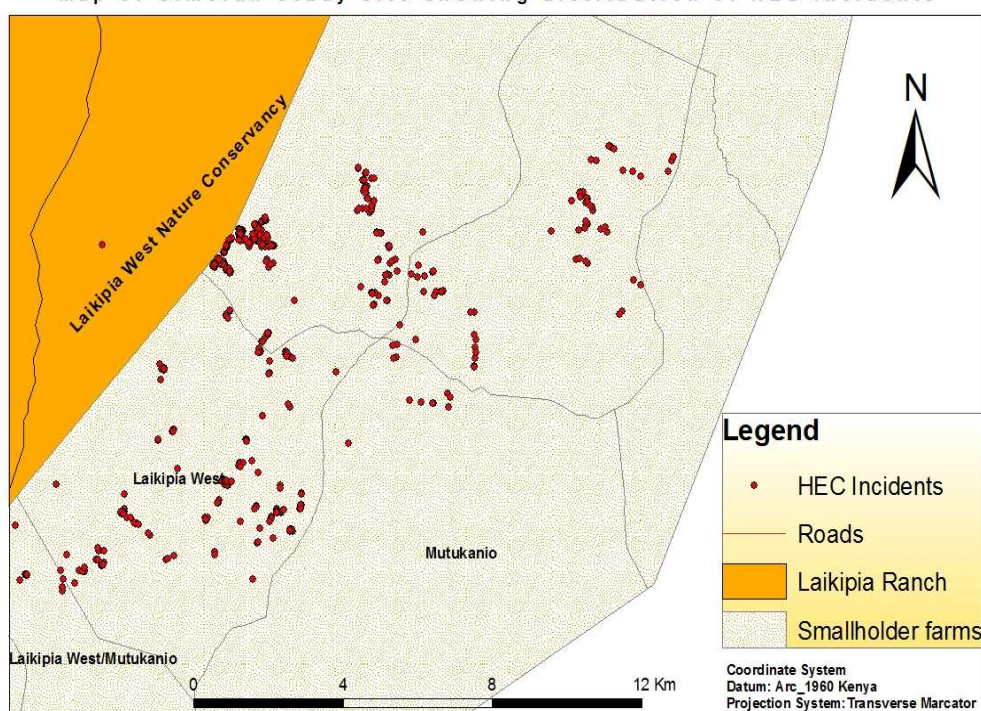
Rumuruti forest was the major elephant refuge in Rumuruti site. This is an open access and unprotected area. HEC incidents were spatially clustered along the forest edge where agricultural farms have encroached onto the forest (Plate 20).

Plate 20: Map of Rumuruti study site showing distribution of HEC incidents



Olmoran has poor quality crops and fallow parcels of land hence HEC is evenly distributed within the landscape. Many cultivated small holder farms were found away from the conservancy fence hence elephants had to move far from the ranch to get to farms (Plate 21).

Plate 21: Map of Olmorán Study site showing distribution of HEC incidents



6.2.3 Elephant crop raiding patterns

HEC in all the three sites involved small group sizes (Figure 5). The range of group sizes was 1-3 with $\geq 90\%$ incidents involving groups of less than 10 elephants. This correlates with $\geq 77\%$ of HEC involving lone bulls. Mixed herds (both males and females) accounted for 21% while cow groups accounted for less than 2% of the incidents (Table 3 and Figure 6).

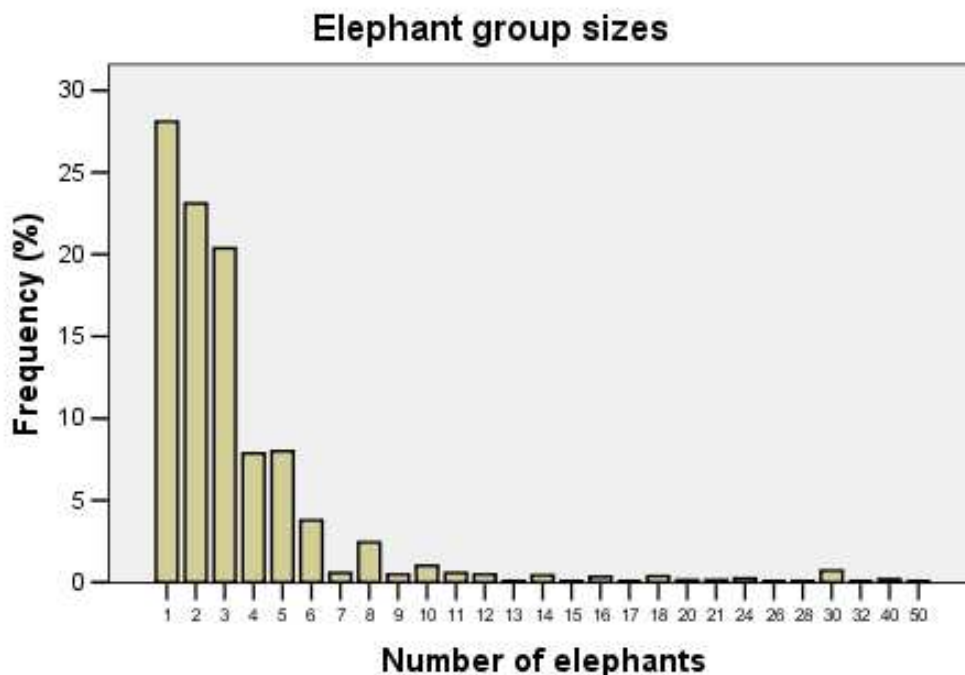


Figure 5: Size-frequency distribution of HEC elephants

Elephant group types involved in conflict in each study site

		Study site			Total
		Mutara	Rumuruti	Olmoran	
Unidentified	Frequency	3	1	2	6
	%	.2%	.3%	.4%	.3%
Bulls	Frequency	1000	187	415	1602
	%	81.5%	59.2%	76.4%	76.8%
Cows	Frequency	23	2	0	25
	%	1.9%	.6%	.0%	1.2%
Mixed	Frequency	196	124	126	446
	%	16.0%	39.2%	23.2%	21.4%
Cow/Calf	Frequency	4	0	0	4
	%	.3%	.0%	.0%	.2%
Bull/Cow	Frequency	1	2	0	3
	%	.1%	.6%	.0%	.1%
Total	Frequency	1227	316	543	2086

Table 3

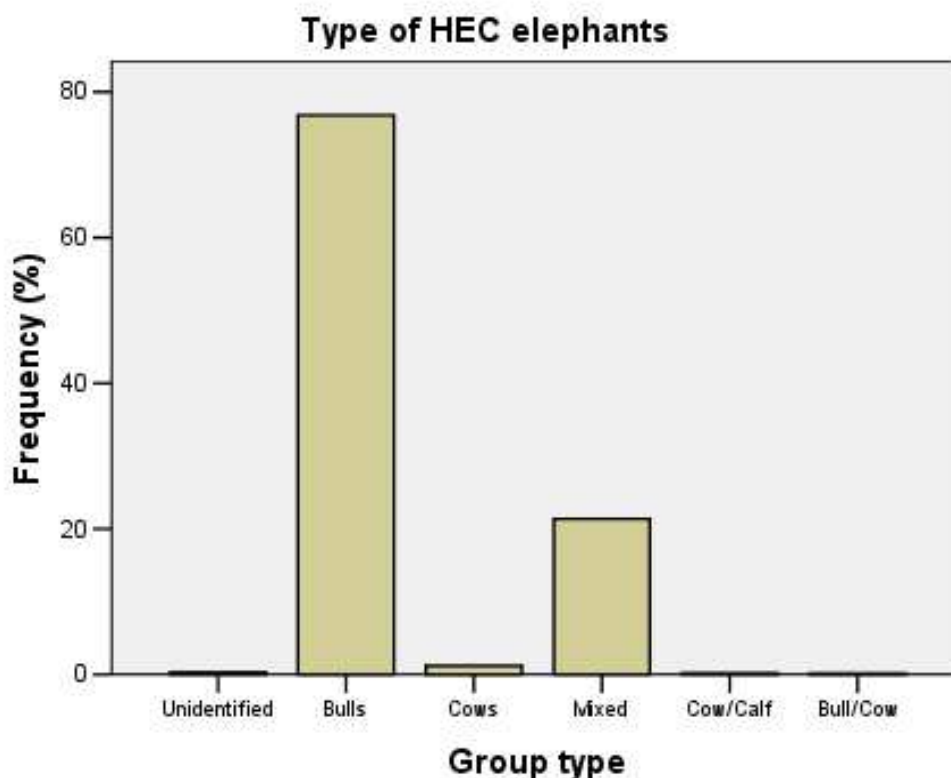


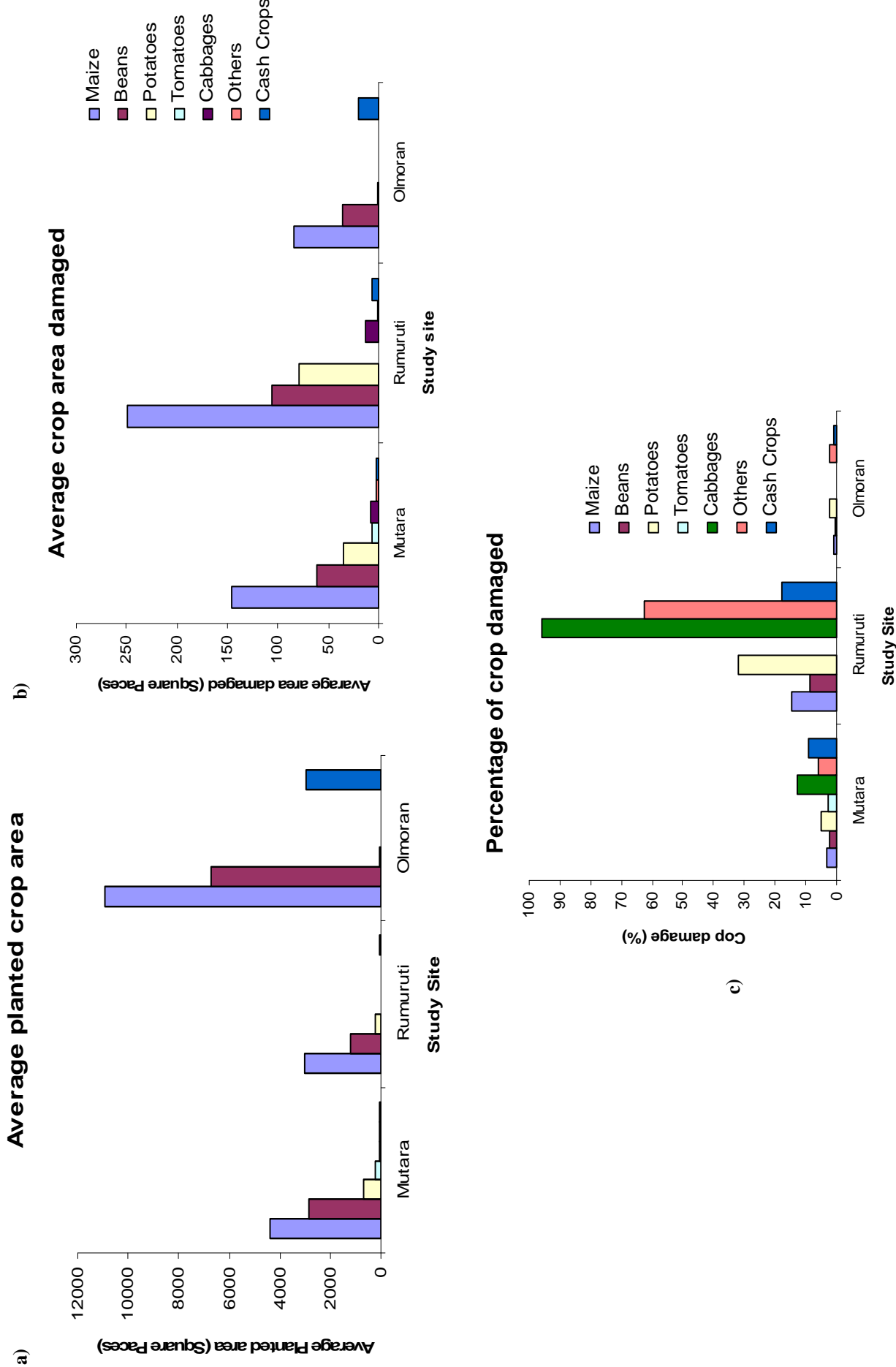
Figure 6: Elephant group types involved in HEC

6.2.4 Crops and crop damage

Maize (*Zea mays*), beans (*Vigna unguiculata*), potatoes (*Solanum tuberosum*), cabbages (*Brassica oleracea*) and tomatoes (*Solanum lycopersicum*) were the most raided crops. Other crops such as snow peas and French beans, and cash crops such as oranges and sugarcane were infrequently damaged. Damage to cabbages in Rumuruti and Mutara was >90% and >10% respectively. Olmorani, where cabbage is least grown had >5% damage to potatoes and other crops as the highest (Figure 7c).

There was an inverse proportionality between average crop area planted and average crop area damaged. During the study period, Rumuruti recorded the lowest average crop area planted ($\leq 3000\text{m}^2$) for maize, beans and potatoes but the highest average crop area damaged ($\geq 80\text{m}^2$) for the same set of crops (Figure 7a and b).

Figure 7: Crops and crop area damage by study site



6.3 HEC mitigation

Local mitigation strategies included noise and shouting, throwing stones, lighting fire, torches and spotlights and beating drums (Table 4). About 28% of the HEC incidents were not detected. Sight and sound (including shouts from neighbours, and other non-elephant sounds) were more effective in combination as an early warning (24%). Dogs and metal strips accounted for <1% of the incidents detected. Similarly, only 1% of the incidents were detected by elephants' tracks (Table 4 and Figure 8).

Mode of elephant detection in the study sites

		Study site			Total
		Mutara	Rumuruti	Olmoran	
Not detected	Frequency	350	91	150	591
	%	16.8%	4.4%	7.2%	28.3%
Sight	Frequency	174	2	157	333
	%	8.3%	.1%	7.5%	16.0%
Sound	Frequency	3	86	0	89
	%	.1%	4.1%	.0%	4.3%
Dogs	Frequency	1	100	0	101
	%	.0%	4.8%	.0%	4.8%
Tracks	Frequency	0	1	0	1
	%	.0%	.0%	.0%	.0%
Sight and sound	Frequency	501	0	0	501
	%	24.0%	.0%	.0%	24.0%
Sound of elephants raiding	Frequency	14	33	1	48
	%	.7%	1.6%	.0%	2.3%
Dogs and sight	Frequency	9	0	2	11
	%	.4%	.0%	.1%	.5%
Sight and sound of elephants raiding	Frequency	138	2	57	197
	%	6.6%	.1%	2.7%	9.4%
Metal strips and sight	Frequency	2	0	3	5
	%	.1%	.0%	.1%	.2%
Dogs, sight and sound of elephants raiding	Frequency	35	0	172	207
	%	1.7%	.0%	8.2%	9.9%
Dogs and sound of elephants raiding	Frequency	0	1	1	2
	%	.0%	.0%	.0%	.1%
Total	Frequency	1227	316	543	2086

Table 4

Overall, elephants left the farms (>70%) when they were confronted using simple mitigation techniques. However, drum beating and stone throwing put the farmers at risk as elephants first charged (>30%) whenever they were used (Figure 9).

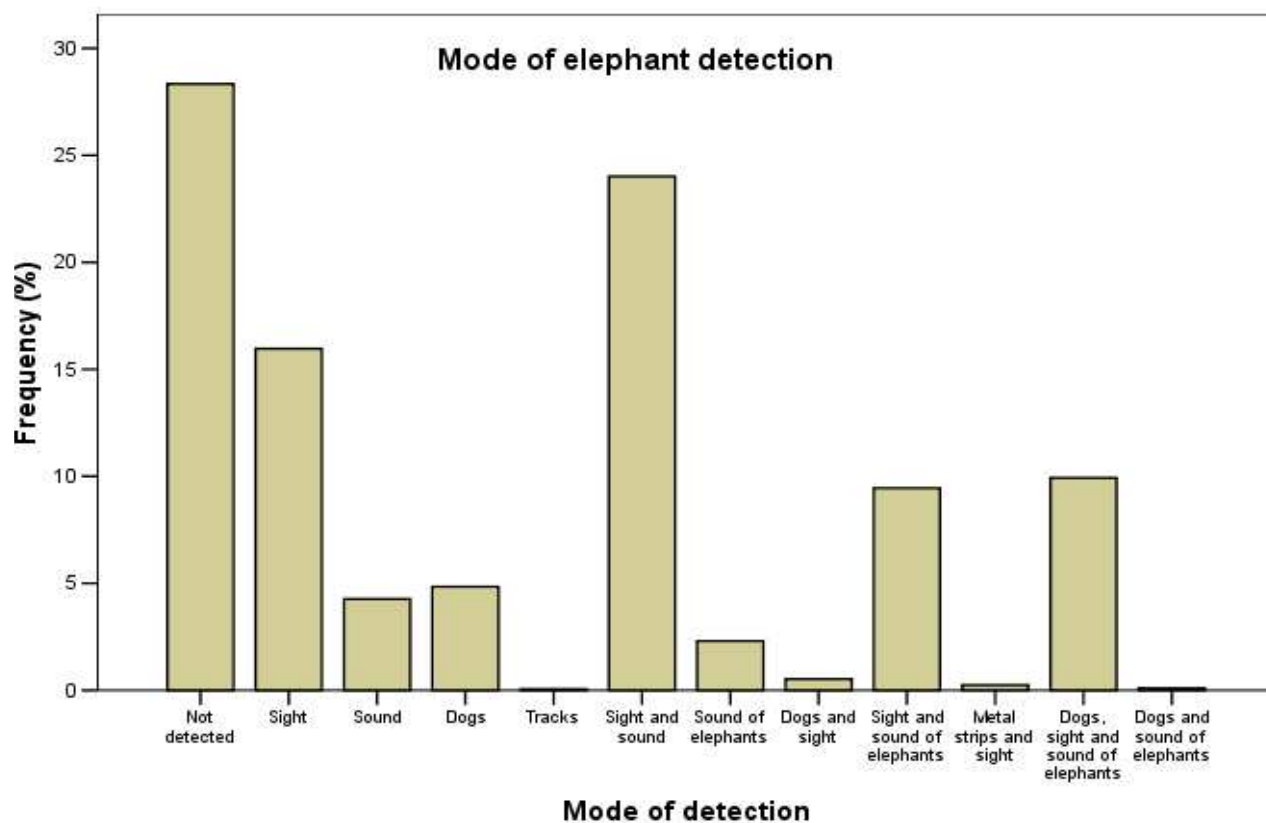


Figure 8

It was not established how elephants reacted to specific combination of the methods since they were used at random.

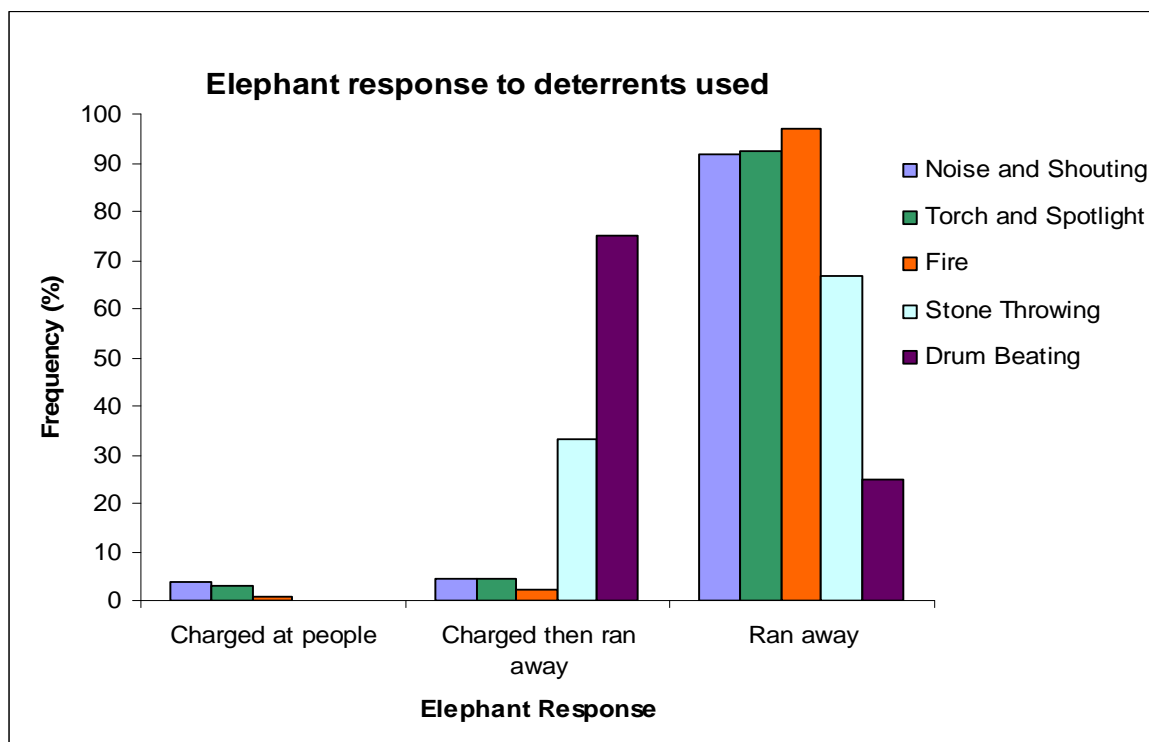


Figure 9

While almost all the incidents (98%) (Table 5) were reported to the Kenya Wildlife Service, >60% of the cases were not attended to while <10% had a response or 'promised' action. >12% were late response while >11% were more of a public relations affair to appease the farmers (Figure 10). 'Promised' action could not be verified as there were no records of any follow-up.

HEC incidents reported to KWS

	Number of incidents	Percentage of incidents
Not reported	49	2.3
Reported	2037	97.7
Total	2086	

Table 5

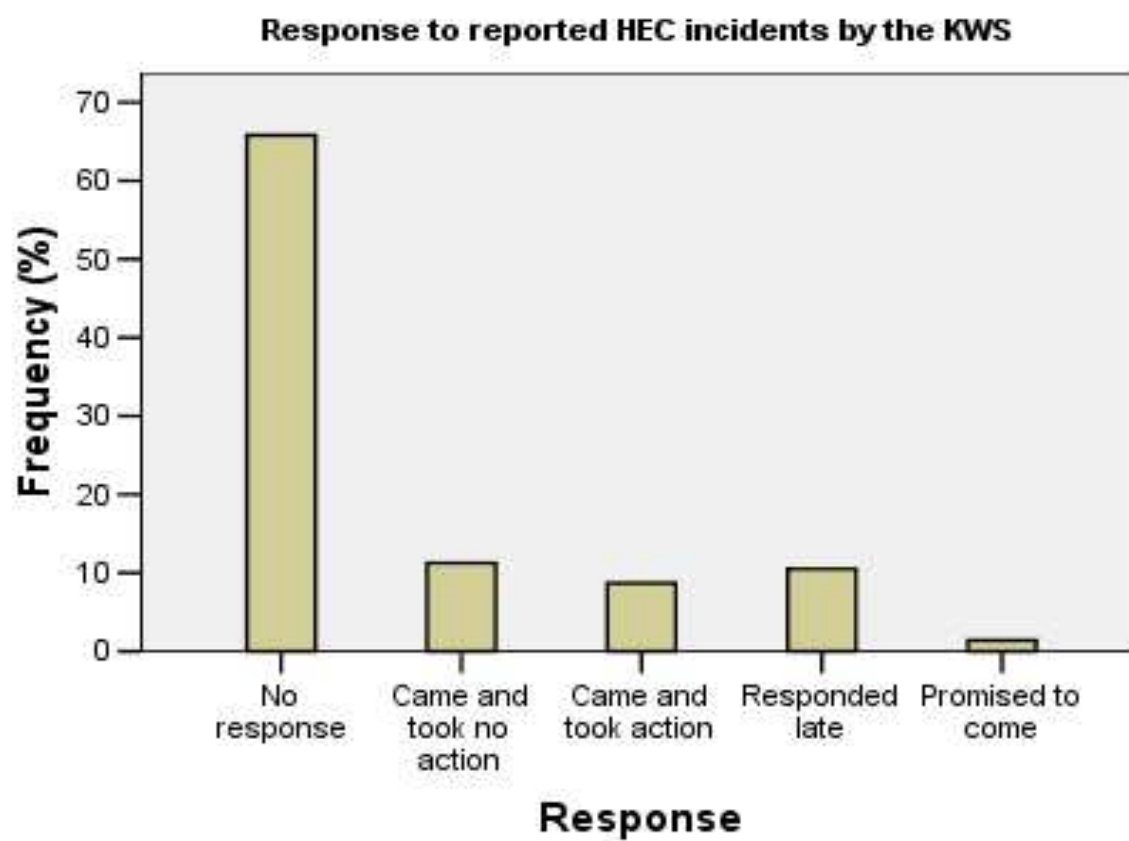


Figure 10

Chapter Seven

Discussion and conclusion

7.1 HEC in Laikipia

This study examined HEC in three rural study sites practising subsistence agriculture within the Laikipia ecosystem. The following results showed that:

- Crop raids are the most dominant form of HEC in Laikipia where elephants feed on diverse crops that are available without any specific preferences. Studies elsewhere have shown that crop raids are rated highly among rural farmers living next to elephant refuges (e.g. Hill, 1997; Naughton-Treves, 1997; Gillingham and Lee, 1999; Taylor, 1993). Crop raids have been linked to crop palatability and lower secondary defences in crops than wild browse plants in both African and Asian HEC studies (e.g. Bell, 1984; Osborn, 1989; Sukumar, 1990). Simple barriers are commonly used to demarcate plots forming part of the fence. Elephants easily break through these fences to access crops and hence the high rates of barrier damage alongside crop raids.
- Maize is the major crop grown in Laikipia covering larger average area in all the three study sites. However, due to the larger planted area, maize crop does not incur severe losses. This can partly be attributed to the fact that elephant's capacity to clear large crop areas in one crop raid episode is ameliorated by large crop areas and partly to the fact that maize crop, being the major crop, is defended well and usually harvested before full maturity (Pers. obs). Interestingly, crops on very small pieces of land incur very severe losses of up to 90% of crop area. However, the general losses of the major crops at individual levels still remain sufficiently high that can lead to abandoning of farms. As Parker and Graham (1989) discovered, African elephants (*Loxodonta Africana*) were a major constraint to arable farming in the pre-colonial Africa (see also Barnes, 1996). Similarly, Laws suggested that only large scale farms could prosper within the elephant ranges in both savannah and forest ecosystems (Laws *et al.*, 1975)
- Results from this study indicate that crop raids were highest during the harvesting periods: September/October and June/July. Coincidentally, these are the seasonal transition periods. There is need therefore, to understand the local dynamics of wild food availability in the context of crop maturity in HEC mitigation (Chinyo *et al.*, 2005). Although Osborn (2004)

attempted to link temporal HEC patterns to seasonal declines in the availability of wild foods in Zimbabwe, studies around Kibale National Park, Uganda, suggested that elephants were attracted to maize crop independent of the availability of wild foods (Naughton-Treves *et al.*, 1998). In addition, the timing of intense crop raids indicates preference for specific crop traits (high density and large patch size), maturity or nutrient density (high sugars, low fibre) which might not be available in wild forage (e.g. Sukumar, 1990).

While it seemed more obvious that elephants would raid in the night, this study found cases, especially in Rumuruti, where HEC incidents occurred during the day. Similarly, Damiba and Ables (1993) discovered that in the daytime, elephants broke grain stores during dry season in villages around the Nazinga ranch in Burkina Faso. Other studies on male elephants, especially those living in unprotected refuges, have shown that they penetrate human settlements in the daytime. This is attributed to the 'disturbance tolerance' by male elephants (Hoare, 1999a).

- Naughton-Treves (1997) in her study discovered that settlements surrounding refuges recorded the most HEC incidents. Similarly, cultivation in forests encourages secondary growth which is highly favourable to elephants (Barnes *et al.*, 1991). Historical accounts indicate that 'front line farms' near refuges in the semi-arid ecosystems in Africa were found to suffer 50-65% of elephant crop depredations (Bell, 1984). Similarly, in his research, Graham (2007) discovered that, in Laikipia, distance from elephant refuges (ranches) and permanent water sources predicted the spatial occurrence of crop-raiding by elephants.

While this study gave similar accounts of HEC distribution, Graham's (2007) finding that crop-raiding intensity was highest at sites with low to intermediate levels of crop cover and lower at sites of intense cultivation was not supported. Crop raids in Mutara, where farms of about 0.25ha are closely knit with intensive irrigated agriculture, were greatest while Olmorani, having large fallow parcels and scattered farms had fewer raids. However, this does not mean that Graham's position is false, other factors both environmental and human, may be responsible for this variation, such as seasonal variability, change in human activities and crop guarding.

- Studies have shown a variation in risks and opportunities from crop raiding between elephant sexes (Lee and Graham, 2006). As Sitati *et al.* (2003) discovered, female elephants' choice of raiding fields is determined by the opportunity costs of travelling further to obtain food while males' is driven by the mortality risks associated with human settlements. This is hypothesised as the reason for higher number of incidents involving male elephants (Hoare, 1999a) reflecting the willingness to take risks for the higher nutritional rewards of mature crops than female elephants.

This 'male behaviour hypothesis' has been supported by empirical studies in Asia and Africa (Sukumar and Gadgil, 1988; Sukumar, 1989). Data for this study showed also that HEC intensity is significantly related to the sex and number of elephants involved. This provides strong evidence that HEC occurrence depends on the behavioural ecology of the male elephants, responsible for the majority of crop-raid events in the study sites in Laikipia, other than spatial patterns.

7.2 HEC mitigation

- Elephant management is strongly influenced by international conservation bodies within the CITES (O'Connell-Rodwell *et al.*, 2000). Both local and international organisations support communities in dealing with HEC. The Kenya Wildlife Service, mandated to manage Kenya's elephants, often has little or no resources hence undertake little or no action in most instances. However, like most rural communities in wildlife ranges, the Laikipia farmers actively report HEC cases expecting the KWS to act. While a policy framework exists for the HEC resolution through shooting, the protocol is such that action is at times delayed and hence failure to address the problem (e.g. O'Connell, 1995). Frustrated, local farmers have resorted to scaring the 'government cattle' (elephants) (pers. obs) using traditional, non-fatal methods such as noise, stones, torches and erecting barriers, choice of which, is dictated by the availability and affordability.

Although farmers favour traditional techniques, many HEC practitioners consider them ineffective and subject to habituation (Bell, 1984; Tchamba, 1996). However, my study reveals that shouting, drum beating, fire, torches and stones were more effective in chasing away elephants in Laikipia. The disappearance of traditional communal guarding in most

parts of Africa indicates the prioritization of human security and safety. As the study results indicate, the failure to detect the elephants before entering crop fields might have been due to lack of guards, and hence alarms (dogs and shouts), due to the elephant aggression and habituation. In addition, my study points to the fact that the number of elephants involved in HEC is central to the ability to detect their presence. Since most of the culprits were males and groups of between 1-10 individuals, there was a possibility of stealth in their movement. Other studies have stressed the need to improve the early warning system as a deterrent technique (e.g., Osborn and Parker, 2002; O'Connell-Rodwell, *et al.*, 2000; Graham and Ochieng, 2008)

- Electrified fences to deter elephants have been used and studied in Laikipia for more than three decades. Results from the comprehensive study by Thouless and Sakwa (1995) revealed a myriad of constraints ranging from design, construction to maintenance. It is obvious that these specifications are beyond the reach of local communities, unless supported by international and external agents. Currently a 128km electrified fence to separate private ranches and forests from farmlands is under construction coordinated by the LWF with the aid of the USAID in Laikipia (Thouless *et al.*, 2002). Similarly, Graham and Ochieng (2008) gave a comprehensive study of the experimental techniques tested on selected farms in Laikipia. Labour, competing interests; political, social and economic, were major obstacle to uptake and implementation of these techniques by the farmers.

7.3 Conclusions and recommendations

In conclusion, therefore, it is important to recognize the interplay between human and wildlife ecological differences. As long as the rural communities engage in agriculture in elephant shared habitats, HEC can only be reduced but not eradicated. The quest for livelihoods and poverty eradication has lead to incompatible land use practices that often conflict with conservation strategies. Indeed, the results of this study showed that people continuously loose crops to elephants in Laikipia, but due to lack of alternatives, continue to grow the same crops, hence, there is an urgent need for a paradigm shift to resolve the HEC. The most sustainable way therefore is to strengthen the capacities and the knowledge of the local people sharing their landscape with elephants to be able to cope with HEC (Osborn and Parker, 2003). Furthermore, they usually have an opinion about which methods are most effective (Hill, 2000; Nyhus *et al.*, 2000). Two coping models can be drawn from the results of this study. One is to strengthen the

traditional conflict mitigation techniques and the other is the promotion of alternative livelihoods that consider wildlife compatible practices.

When people's coping strategies are enhanced, they can easily tolerate wildlife around them. In the event of failure, wildlife conservation, especially of threatened and endangered species, is bound to be affected. Indeed, the centralized management of HEC is riddled with deep financial and human resource difficulties as evidenced in most parts of the African elephant ranges. This study suggests that traditional methods are best placed to reduce conflicts. Indeed, focusing a combination of traditional techniques especially in the front-line farms may be the most successful short-term approach to crop depredation. However, comprehensive field tests of the efficacy of such methods are vital to identify the most appropriate combination. Electrified fencing is probably the most effective method for long-term solution where financial constraints are addressed. Improving the early warning systems for elephant detection through strategic implementation can reduce crop losses. From this study, it is evident that if farmers were able to detect elephants before entering farms, they could successfully deter them. Based on knowledge enhancement, local farmers need to be encouraged to change cropping regimes, to reflect crop diversification and seasonal planting and harvesting variations (timing).

With the continued crop losses and unpredictable weather, there is need to encourage local communities to engage in compatible land-use planning that will integrate both elephant and human needs. Eventually, it might be prudent to shift from subsistence farming to an economy based entirely on wildlife revenue. This would offset the costs of conservation through benefits sharing from both consumptive and non-consumptive use. However, wildlife, being a significant resource in most African governments, has become a political commodity, and wildlife conservation policies are at the centre of disputes between individuals, groups and governments, hence a comprehensive land use and conservation policy review to integrate both human and wildlife needs will be required. Successful conservation needs to be integrated into land-use policies, particularly the agricultural policy. However, this must be guided by the most accurate and up to date scientific data which at the moment is more descriptive than analytical.

Appendix

Appendix 1: THE LAIKIPIA ELEPHANT PROJECT

The Laikipia Elephant Project



The Laikipia Elephant Project

Laikipia District

Warning Systems

Alternative Livelihoods

Community Education

Elephant Deterrence

Project Papers

Project Partners

Project People

WebMag

BUILDING CAPACITY TO ALLEVIATE HUMAN-ELEPHANT CONFLICT IN NORTH KENYA:

This project is being implemented by the University of Cambridge in collaboration with [local partner organisations](#) through funding provided by the [UK Darwin Initiative](#).

Project Aims

This project aims to enhance the conservation and management of Kenya's second largest elephant population and the ecosystems they inhabit through the implementation of a sustainable community based approach for alleviating human-elephant conflict ("HEC").

What is HEC?



HEC refers to the negative impacts to people and elephants as a consequence of sharing space and resources. Such impacts include human deaths and injuries, elephant deaths and injuries, damage to crops and the constraints presented to general day to day human activities (e.g. collecting firewood, travelling to school).

In the absence of commercial poaching, human-elephant conflict presents the greatest threat to elephants, eroding local support for conservation and often leading to elephants being killed either legally by the wildlife authorities or illegally by angry local farmers. As a consequence HEC is increasingly recognised as a major conservation and human livelihood problem in Africa and Asia.


Further info on HEC, visit: [IUCN Human-Elephant Conflict Task Force](#)




Appendix 2: THE CENTER FOR TRAINING AND INTEGRATED RESEARCH IN ASAL DEVELOPMENT

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Ministry of Water and
Irrigation
KENYA



Centre for Development and
Environment
Institute of Geography
University of Bern
SWITZERLAND

WELCOME

CETRAD'S MANDATE

CETRAD's mandate is the ASALs, and focuses on the assessment and evaluation of the potential and the utilisation of the resources in the said areas. This mandate as well includes the assessment and evaluation of the interaction and relations between the ASAL and the high potential areas (in particular mountains and highlands) on the one hand, and the interaction and relations with the economic core regions (in particular urban centres).

This mandate is, therefore, twofold: to undertake practical oriented and field-based training in order to build the required technical and professional capacities for ASAL development; and to carry out area or situation-specific, regionally oriented and applied research for the purpose of developing and maintaining an integrated and comprehensive data and information base for the entire Arid and Semi Arid Lands (ASAL) of Kenya in order to:

- Understand the natural resource base and assess its potential in view of the ecological and socio-economic dynamics currently taking place in the ASALs.
- Develop appropriate technological packages and strategies for sustainable resource utilisation in the ASALs and
- Understand and integrate the multitude of the sectoral actors and varied strategies and approaches influencing development processes in the ASALs

Plotting Services

CETRAD is pleased to inform our clients and the public in general that from May 2008 we are offering plotting services. Therefore, for the production and printing of maps, please contact the GIS Department for details.



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ABOUT US OVERVIEW



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CETRAD is a Bilateral Institution between the Government of Kenya (through the Ministry of Water and Irrigation) and the Government of Swiss Confederation, through the Centre for Development and Environment of the University of Berne. CETRAD was established in July 2002 as a follow up of the then Laikipia Research Programme (1976 - 1997), and therefore builds on the long term preinvestment research facility.

CETRAD is based in Nanyuki, Laikipia District, Kenya. It is concerned with research and training to design strategies for sustainable development, promote land use planning for sustained livelihood and optimal resource use, foster sustainable resource use and management for improved productivity and promote non-farm, non-pastoral enterprises, infrastructure and related services. Organisation.

CETRAD is organized into four thematic departments and a support department responsible for Administration, Logistics and Finance. The four are:

- Geographic Information Systems and Remote Sensing
- Information Dissemination and Technology Transfer
- Socio-economics Research
- Natural Resource Management and Ecology Research

Appendix 3: HEC Enumeration Form

LAIKIPIA ELEPHANT PROJECT - INCIDENT REPORTING FORM

Version 1.2

(Be as accurate as possible, but make approximation if necessary)

1. Date and Time of incident: (dd-mmm-yy): _____ Time (hh:mm): _____ ☐ am
☐ pm
2. Date and Time report written: (dd-mmm-yy): _____ Time (hh:mm): _____ ☐ am
☐ pm
3. Property or Area: _____ GPS Nothing ☐☐☐☐☐☐☐☐ GPS Easting ☐☐☐☐☐☐☐☐
4. Sub-location: _____ Name of reporter: _____
5. Name of complainant(s): _____
6. Has this incident been reported previously? No ☐ Yes ☐ - if Yes, give details below

7. Type of Incident

☐ Crop raiding: ☐ Structure damage ☐ Barrier damage ☐ Human Casualties ☐ Livestock losses:

☐ Other type of incident (specify) _____ Give details below:

.....

8. Narrative report and additional comments

9. Authorities Notified:

Were any authorities notified? No ☐ Yes ☐

If yes, give details below:

Authority Notified:	Date:	Time:	Reported by:	Authority's response:	Response helpful?

--	--	--	--	--	--

10. Elephant Raiding details:

Time In: _____ Time Out: _____

Direction of Travel: Came from.....Went to.....

Known Individual(s)? No ☐ Yes ☐ give name and distinguishing characteristics below.

.....

.....

Elephant Details

GROUP SIZE (Total)	GROUP TYPE (Males, Females, Immatures, Mixed)	VISUAL ID (Complainant)	VISUAL ID (Reporter)	TRACK ID (Reporter)

Quality of count: Estimate ☐ Good Estimate ☐ Exact ☐ Don't Know ☐Identified by: Tracks ☐ Spoor ☐**11. Elephant(s) detected at time of incident?** Yes ☐ No ☐

If yes, Detection Method:

- ☐ Metal Strips
- ☐ Dog
- ☐ Sight
- ☐ Sound of elephants raiding
- ☐ Livestock response
- ☐ Cow Bells
- ☐ E-Fence Alarm
- ☐ Other

12. Deterrents used:

- ☐ Torch
- ☐ Thunderflashes
- ☐ Chilli dung smoke
- ☐ Home made bangers
- ☐ Noise (shouting, drum beating)
- ☐ Watchtower and spotlight

☐ Fire☐ OtherRESPONSE OF Animal(s) ☐ None ☐ Ran away ☐ Charged ☐ Other

Comments:.....

.....

.....

SHAMBA (Name of Owner):.....

Plot No.....

VISIT ☐ RAID ☐ Crop Damage: Yes ☐ No ☐

Crop			Quality of Crop			Age of Crop		
Crop Present	Planted area	Damaged area	Good	Medium	Poor	Seedling	Interim	Mature

☐ **Structure damage**Structure Type: Food store ☐ Water Tank ☐ Water pipe ☐ Dam ☐ Other ☐

.....

☐ **Barrier damage**Barrier Type: ☐ Chilly Fence with bells☐ Chilly Fence without bells☐ Cactus☐ Live Hedge☐ Dry Vegetation☐ Barbed Wire Fence

☐ Electric

☐ Other _____

If Electric: Total number of strands _____ Number of electrified ones _____ Voltage _____

☐ **Human Casualties:**

Were humans threatened? No ☐ Yes ☐

Name	Age (yrs)	Gender	Killed/Injured	Comments/ Details

☐ **Livestock losses:**

Stock lost from: Boma ☐ while grazing ☐ Stray ☐ Was livestock guarded? No ☐ Yes ☐. If Yes, by:

Adults ☐ Juveniles ☐

Livestock Type	Total Livestock Present	Adult Males Killed	Adult Males Wounded	Adult Females Killed	Adult Females Wounded	Immatures Killed	Immatures Wounded

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